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Related to the Silicate Industries

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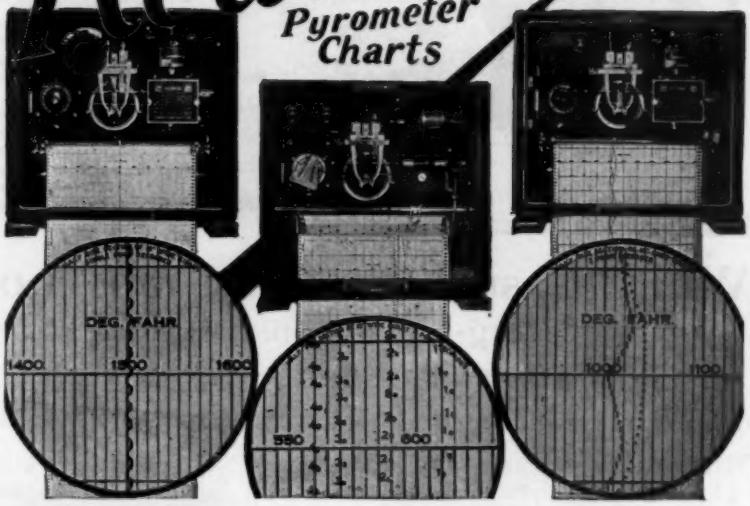

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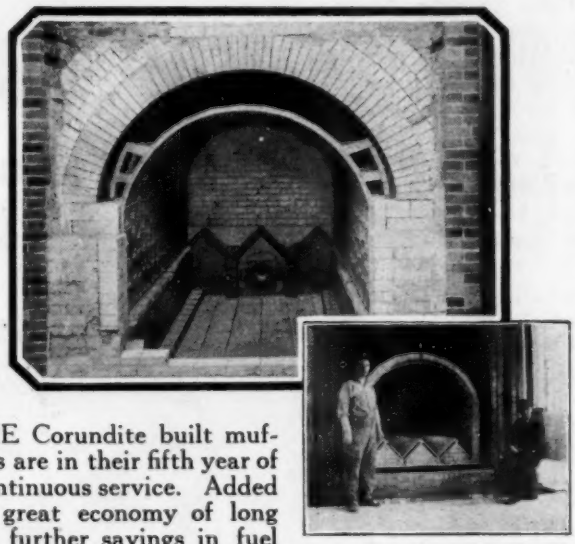

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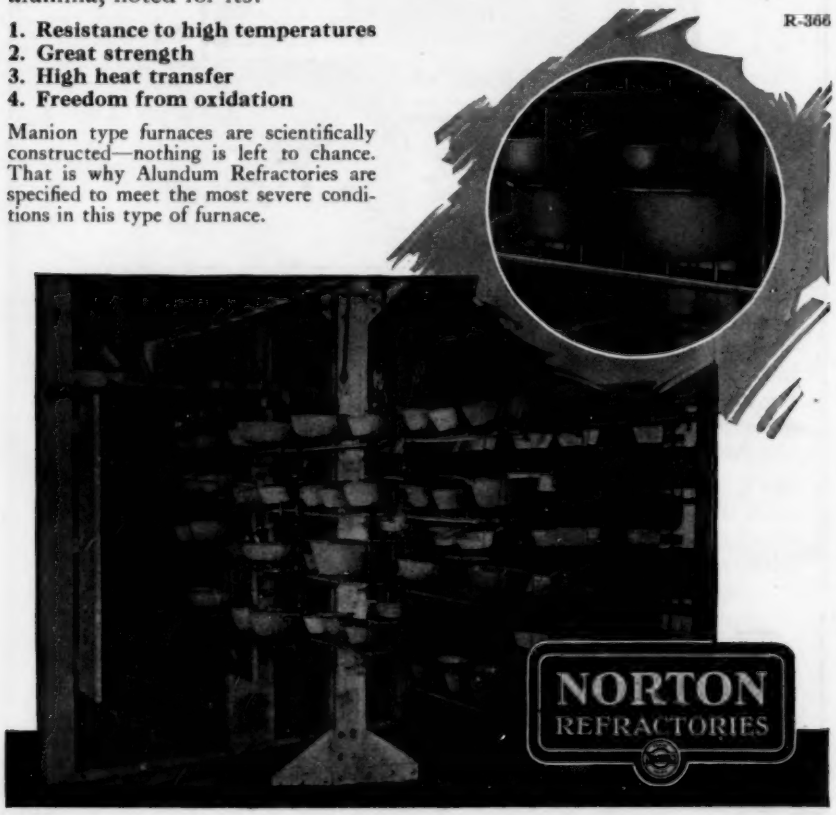

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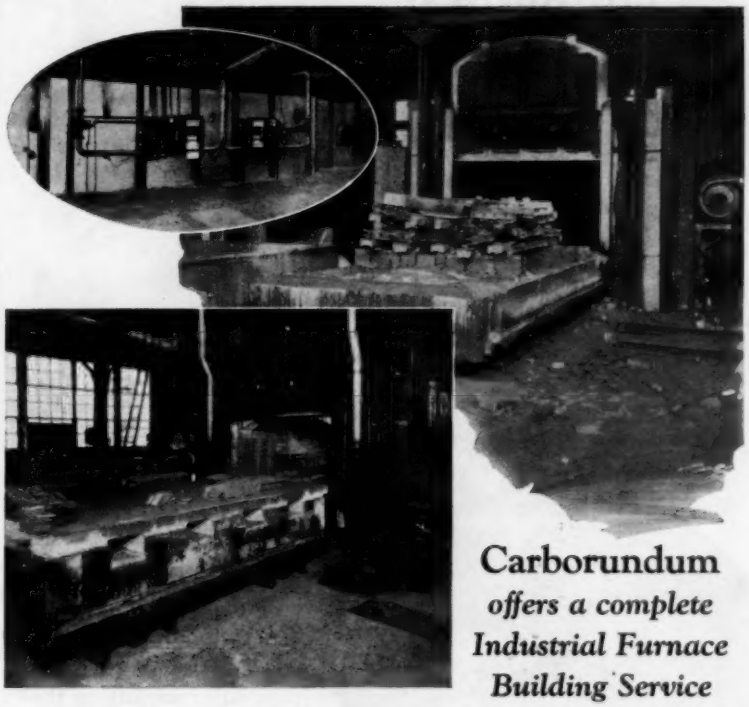

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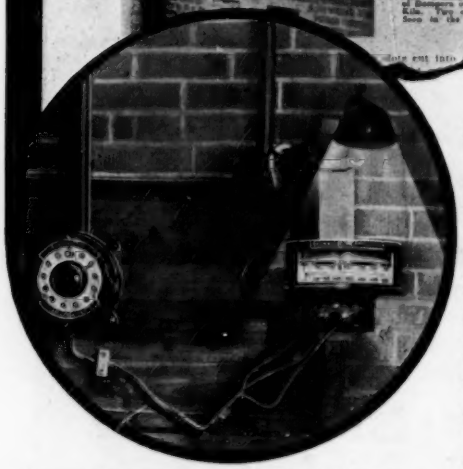

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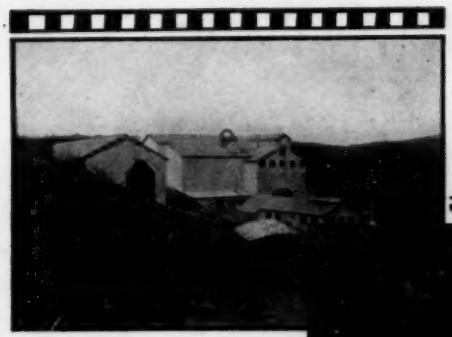

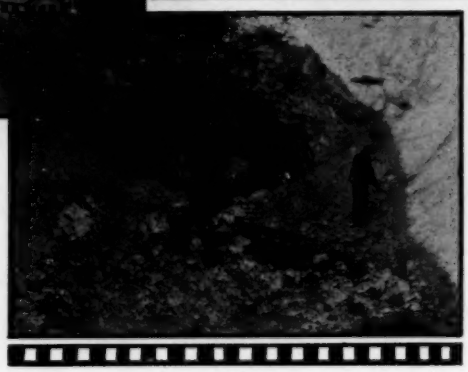

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THE MEASUREMENT OF ABSOLUTE VISCOSITY BY THE USE OF CONCENTRIC CYLINDERS[1]

By Howard R. Lillie[2]

ABSTRACT

A method is described for the measurement of absolute viscosities of liquids, employing the torque exerted upon a stationary inner cylinder or spindle, suspended by means of a torsion member into the center of a fluid, when the cylindrical container is given a uniform angular motion. A method for calibrating the suspensions is described. The "true" viscosity of the castor oil, used as a test fluid, is found by extrapolating values of apparent viscosity, given by spindles of various lengths but equal radii, to that value corresponding to infinite length. For the oil being used, the viscosity at 20°C is given by this method as 9.67 poises. Using this as the true value, the effective length and thereby the end effect in terms of additional length may be found for any spindle in a liquid of given finite boundaries. The end correction to length, so determined for a spindle of 0.5 cm. radius by 10 cm. length in the center of a liquid of boundaries 3.2 cm. radius by 13 cm. height, a system similar to that used in measuring glass viscosities, was found to be 0.44 cm.

Introduction

Many methods have been used in the past for the direct measurement or the comparison of viscosities. Nearly all these are varied or improved forms of a few fundamental methods.

With the object of finding a method for the absolute measurement of viscosity, which could later be applied to measurements in glass at high temperatures and over a large range of viscosities, a study was made of these few fundamental methods and their limitations and advantages. A brief review of this study will be included here.

Capillary Flow Method This is the most familiar of all, being used to a great extent by various industries for measuring viscosities of oils, syrups, etc. As a rule, the viscosity is not measured in terms of poises, but is only stated in terms of time required for a certain flow under specified conditions. If conditions are very well regulated, the density and surface tension accounted for, and the dimensions of the apparatus measured accurately, this method yields very satisfactory results for absolute viscosity. For measurements in glass it would be a difficult method to use since the orifice must be opened and closed and must be able to withstand corrosion. The whole apparatus would of necessity be in a furnace and not readily accessible. Frink, in 1910, used a flow method but assumed the viscosity to be proportional to the width of the stream.

Falling or Rising Spheres The velocity of movement of a sphere through a medium can be used as a measure of viscosity. Due, however, to the correction for finite boundaries being of rather

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Illinois, February, 1929. (Glass Division.) Received March 27, 1929.

[2] Corning Glass Works, Corning, N. Y.

large importance and not very well understood, this method must usually be calibrated by means of a substance of known viscosity. Standards of viscosity, in which conditions of shear can be similar to those in a substance like glass, are not available. Several workers, like Stott,[3] have employed this method by the use of a calibrating constant. Their results are discussed in a later paper on glass viscosities.

Drawing of Wire from Liquid By drawing a wire slowly out of a liquid, the amount of liquid adhering to the wire can, by proper calculation, taking surface tension into account, be made a measure of viscosity. This method has been used very little, but some good results were obtained by its use recently by Stott[4] in his work with glass. His measurements, however, were based on a calibration with a glass which had been previously measured by other methods, and were of value only in showing the small changes in viscosity accompanying heat treatment of glass.

Rate of Insertion The rate at which a point or a blunt object will penetrate the surface of a substance has been used as a measure of viscosities of high magnitude. Rough measurements of the viscosity of glasses have been easily accomplished here by this method, but since the action of the penetrating object cannot be expressed well enough mathematically to allow absolute measurement, all the results are purely relative and must be based on previous calibration.

Concentric Cylinders Another method which has been worked out as well mathematically, for the ideal case, as has the method of capillary flow, is that which involves the torque necessary to turn one cylinder which is separated from another stationary cylinder by the medium under examination. This method has been used by Gilchrist in measuring the viscosity of gases, and in varied forms by Washburn[5] and English[6] in their work with glass. In these latter forms the parts of the apparatus were not in the form of true cylinders, and the inside member was turned by a falling weight while the crucible remained at rest. Friction losses had to be calculated and results based on previous calibration.

Of these five fundamental methods there are but three, capillary flow, moving spheres, and concentric cylinders, which lend themselves to abso-

[3] Stott, Irvine and Turner, "Viscosity Measurements with Glass," *Proc. Roy. Soc.*, **108,** 154 (1925).

[4] Stott, Turner, Sloman, "Effect of Thermal Treatment on Glass, etc.," *Proc. Roy. Soc.*, **112,** 499 (1926).

[5] Washburn, Libman, and Shelton, "The Viscosities and Surface Tensions of the Soda-Lime-Silica Glasses at High Temperatures," Univ. of Illinois, Eng. Expt. Sta., *Bull.*, No. 140 (1924).

[6] S. English, "The Effect of Composition on the Viscosity of Glass," (Part II), *Jour. Soc. Glass Tech.*, **8** [31], 205 (1924).

lute measurements, free from empirical calibration. The last of these is the most easily applied to measurements in glass.

By measuring the torque on a stationary spindle while the crucible is rotated at a measured rate, the effect of friction is eliminated, and by making the crucible and spindle truly cylindrical, the measurement can be made independent of empirical calibration.

Apparatus and Procedure

Apparatus The main parts of the viscometer are shown diagrammatically in Fig. 1 and photographically in Fig. 6. The table, T, 12 inches in diameter, is supported on ball bearings in a circle of about 5 inches diameter and is driven at G through a worm and gear. To this table is fastened the cylinder containing the medium under examination. The head, H, which can be raised or lowered on the large hollow uprights, A, to suit the experiment at hand contains, directly over the center of the table T, a pair of eccentric cylinders so fitted as to allow the rod, R, to be adjusted to the exact center of rotation. At the lower end of R is a chuck, C, into which the end pieces of the suspensions are fastened. The whole is supported on three legs, L, fitted with leveling screws to provide for proper adjustment of height and level. All these parts are of cast iron and steel. The driving mechanism is not shown in the drawing but is shown in the photograph. At present, it consists of a reversible $^1/_4$ H.P., 1100 r.p.m., d.c. motor which drives the fast side of a 20–1 reduction unit through one of three speed ratios of 3–2, 1–1, 2–3. The slow side of this unit is direct-connected through universal joints to the worm at G in Fig. 1 where a second 20–1 reduction takes place. By using a continuous tapered type belt between the motor and the reduction unit, and by carefully fitting the gears at G, very uniform velocities may be obtained at three speeds of approximately 12, 18, and 27 seconds per revolution.

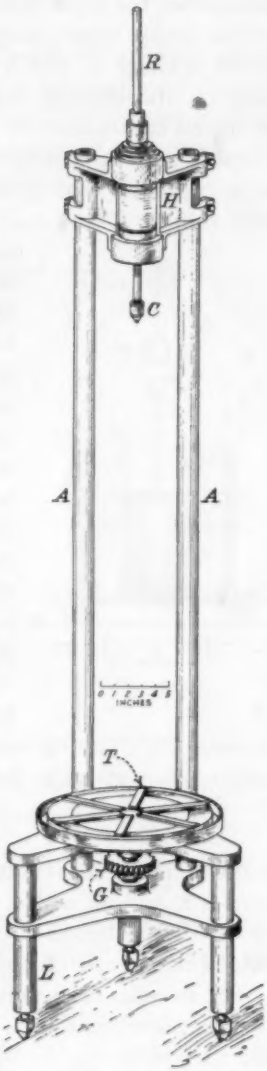

FIG. 1.

In the work to be reported here, the object was to examine the devia-

tion from the equation for the ideal case, when the inner cylinder consists of a spindle of finite length. Both spindle and crucible have flat ends separated by a thickness of medium in the order of 1.5 cm. For this examination, the liquid used has been castor oil at room temperature. The rather simple experimental set-up is shown in Fig. 2. The oil is contained in the cylinder A, and is surrounded by an annular space filled with water and, on the extreme outside by asbestos wrapping. The temperature of the oil is measured by means of two sets of copper-constantan thermocouples, with three couples in series in each set, placed at the inner surface of A. All the cold junctions were maintained at 0°C by means of ice and water. The e.m.f.'s were measured on a precision potentiometer and the temperatures read on a curve previously determined by calibrating the couples at the boiling point of water. This e.m.f. is about 2.5 m.v. for room temperature and, since the potentiometer is accurate to less than 0.002 m.v., the temperature is easily accurate to 0.05°C if the cold junctions are kept well covered with ice. When room temperature was being used, the temperature as shown by these couples was assumed to represent that of the oil, but later some indication was observed that this condition was not strictly true due to a slight rise in room temperature during a run, and to the continual changing of spindles and disturbing of the oil.

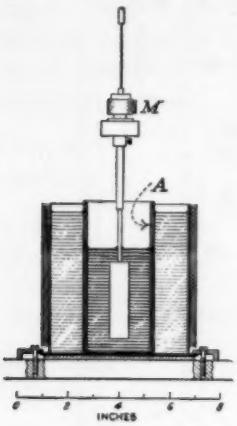

FIG. 2.

Each value for apparent viscosity was converted to a corresponding value at a standard temperature (usually 20°C) by the use of a conversion graph plotted from the data for castor oil as given in Smithsonian Tables, according to the following:

$$F_t = \eta_{20}/\eta_t$$

where F_t is the conversion factor to be applied when the recorded temperature is t, and η_{20} and η_t are values from the Tables. This of course assumes that although η itself may differ from that of the pure standard, its rate of change with temperature is standard over small ranges.

The spindles used were of several different sizes, all of them of the same type as shown in Fig. 2, cylindrical with flat ends, and supported through the surface of the oil by $^1/_{16}$-inch drill rod. The torque on a steel-wire suspension was measured by means of a mirror at M and a telescope and straight scale at a measured distance of about one meter.

The suspensions used were of steel wire soldered into brass end pieces as shown in Fig. 3(a). The end pieces are about $^3/_{16}$ inch diameter and about $^5/_8$ inch long. A small hole is centered through their axes to admit

the wire and the solder applied with a small iron to prevent overheating the steel. The length of the wire between the two end pieces is about $2^1/_2$ inches, and its diameter is from 0.007 to 0.030 inch depending on the sensitivity desired. For the work with castor oil, three were used, of diameters about 0.007, 0.009, and 0.016 inch.

The constant, K, of a suspension in terms of the torque in dyne centimeters per radian of twist is found by making a torsional pedulum of varying moment of inertia as shown in Fig. 3(*b*). (Only one arm of the inertia member is shown.) Four pairs of masses, M, are used and

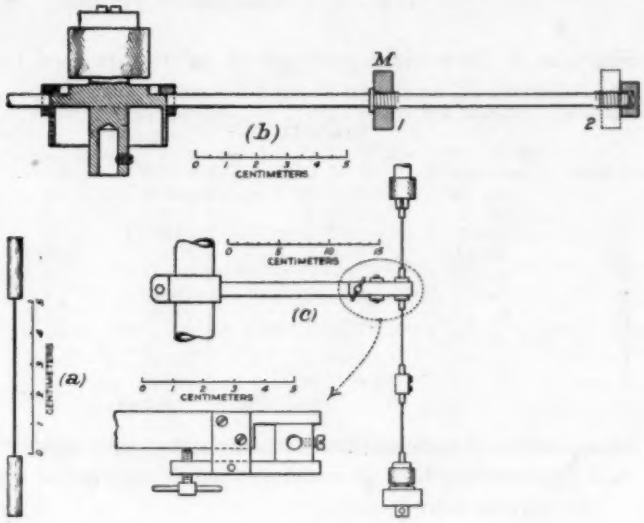

FIG. 3.

the period of the system carefully determined with each pair in the positions *1* and *2*. The period of such a system is expressed by

$$T = 2\pi \sqrt{\frac{I}{K}}$$

where I is the moment of inertia and K is the constant to be determined. Now if for two moments of inertia I_1 and I_2 the periods are T_1 and T_2

$$K = \frac{4\pi^2(I_1 - I_2)}{T_1^2 - T_2^2} = \frac{4\pi^2 \Delta I}{\Delta(T^2)}$$

By using this formula, the part of I which is constant is eliminated, and only that variable part which is in the masses, M, may be used in calculating ΔI.

Four pairs of masses were used on this device. Calling these by number and the position of smaller radius by (*a*) and that of larger radius by (*b*), the moments of inertia were found as follows:

TABLE I

Mass	Thickness t	Distance d*	Moment of inertia $2Mr^2$
(1) 3.196 g.	0.62	(*a*) 8.81	531.7
		(*b*) 16.31	1765.2
(2) 5.901 g.	0.62	(*a*) 8.81	981.7
		(*b*) 16.31	3258.2
(3) 13.652 g.	0.61	(*a*) 8.81	2267.3
		(*b*) 16.31	7539.8
(4) 22.796 g.	0.75	(*a*) 8.81	3803.0
		(*b*) 16.16	12471.6

* This is the distance from the center of the system to the inside edge of the mass. The radius of gyration r is found by

$$r^2 = \frac{d^2 + (d + t)^2}{2}$$

Ten combinations of these eight moments of inertia are used for determinating the constant, K, as shown in the following table:

TABLE II

Combination	Consisting of	ΔI	Log $K(\Delta T^2)$	Weight (proportional to ΔI)
A	1*a*, 1*b*	1233.5	4.68750	1
B	2*a*, 2*b*	2276.5	4.95362	2
C	3*a*, 3*b*	5272.5	5.31838	5
D	4*a*, 4*b*	8668.6	5.53431	8.5
E	1*a*, 2*a*	450.0	4.24957	0.5
F	2*a*, 3*a*	1285.6	4.70547	1
G	3*a*, 4*a*	1535.7	4.78266	1.5
H	1*b*, 2*b*	1493.0	4.77042	1.5
I	2*b*, 3*b*	4281.6	5.22797	4
J	3*b*, 4*b*	4931.8	5.28936	5
			Total wt.	30

As an example of a determination of the constant of a suspension, we will take the largest of the three suspensions used in the present work with castor oil. The periods were found as:

Condition	Period (sec.)	Condition	Period (sec.)
1*a*	2.224	3*a*	2.564
1*b*	2.468	3*b*	3.390
2*a*	2.310	4*a*	2.834
2*b*	2.740	4*b*	4.018

Using the combinations as listed in Table II, we find ΔT^2 and K as follows:

TABLE III

Combination	ΔT^2	Log ΔT^2	K
A	1.1448	0.05873	4.254×10^4
B	2.1715	0.33676	4.139
C	4.9180	0.69179	4.232
D	8.1128	0.90917	4.218
E	0.3899	9.59095	4.556
F	1.2380	0.09272	4.100
G	1.4575	0.16361	4.160
H	1.4166	0.15124	4.161
I	3.9845	0.60037	4.243
J	4.6422	0.66673	4.194

The mean of these values, weighted according to the weights shown in the last column of Table II, is 4.21×10^4 dyne cm./radian.

In actual measurements, either of the variation of viscosity with temperature, or of the variation of torque, using various-sized spindles, it is necessary to be able to change the sensitivity of the suspension unit in order to have the greatest deflection. To accomplish this without having to remove one suspension and substitute another in its place, three suspensions with a total range of about a factor of 100 in their constant are coupled in series, as shown in Fig. 3(*c*), by means of square brass collars which can be held in a clamp as shown. In this way, by having the strongest of the suspensions at the bottom, three constants can be used which are computed by the formula

$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2} + \cdots\cdots$$

In the work with castor oil, the most recent set of such constants was:

3 suspensions 9.22×10^2 dyne cm./radian
2 suspensions 4.72×10^3
1 suspension 4.21×10^4

Mathematical Procedure

A derivation for the torque exerted on the spindle in this type of apparatus, for the ideal case of infinitely long cylinders, may be found in Webster's Dynamics.[7] In this derivation, the velocity function between the cylinders is found to be

$$\omega = \frac{\Omega R_2^2}{R_2^2 - R_1^2} \left\{ 1 - \frac{R_1^2}{r^2} \right\}$$

This has been changed slightly to suit the case at hand, namely, that in which the rotating cylinder of radius R_2 is larger than the stationary one of radius R_1.

From this velocity function is derived the expression for torque per unit length upon an infinitely long spindle:

$$\frac{T}{l} = \frac{4\pi\eta\Omega R_1^2 R_2^2}{R_2^2 - R_1^2}$$

If the additional torque due to the finite length of the cylinders be neglected, the last expression becomes

$$T = C\eta\Omega l$$

where T is torque in dyne cm., C is a constant dependent upon the radii of the two cylinders and equal to

$$\frac{4\pi R_1^2 R_2^2}{R_2^2 - R_1^2}$$

η is the apparent viscosity of the medium, Ω the angular velocity of the outside container, and l the length of the spindle.

[7] A. G. Webster, Dynamics of Particles and of Rigid, Elastic, and Fluid Bodies, 1912, p. 553.

Now the torque, T, is measured by the amount of twist caused in a calibrated suspension, and is equal to $K\theta$, where θ is the angular displacement of the mirror. To allow various scale distances to be employed, a straight scale is used; the tangent of twice the angle is therefore the quantity actually read. Now if

$$Z = \frac{d \cdot \tan^{-1}(D/d)}{D}$$

this quantity can be plotted against D/d and used as the correction factor for changing deflections into their equivalents on a circular scale. Therefore

$$\theta = \frac{ZD}{2d}, \; T = \frac{KZD}{2d}$$

Now if the angular velocity is measured by means of timing the rotation of the table, $\Omega = 2\pi/t$, where t is time per revolution, and

$$\eta = \frac{T}{C\Omega L} = \frac{KZDt}{4\pi CdL} \tag{1}$$

An approximate correction for the stem of the spindle is made by adding to the length, l, a length

$$l' = \frac{R'^2 x}{R_1^2}$$

where R' is the radius of the stem and x its length of immersion.

All the quantities contained in the last expression for η can be determined. The viscosity found will be only apparent, however, since we neglected the torque on the ends of the spindle, and it now remains to find what further amount will have to be added to l in order to determine the total effective length L.

Determination of "f" The amount, f, is defined as the length which must be added to the actual length of a spindle $(l + l')$ to give the effective length to be substituted in the expression for viscosity (1).

To determine this quantity several spindles of various lengths and constant radii may be used, keeping all other conditions as constant as possible. Putting the length of the spindle, uncorrected for the end torque, in place of L in equation (1), the apparent viscosity of the medium can be found for the various lengths. Since the end torque will remain nearly the same for all the spindles of equal radius, it will become a smaller and smaller fraction of the whole torque as the spindle length, L, is increased. The apparent viscosity will always be greater than the true viscosity and will approach the true value as L approaches infinity. Therefore, if apparent viscosity be plotted against the reciprocal of the length, L, the intercept at $1/L = 0$ would be the true viscosity of the medium.

It was hoped that by using twenty-five spindles, consisting of five different diameters and five different lengths, and by varying successively the radius of the containing cylinder and the distance from the bottom of this cylinder to the bottom of the spindles, this "end effect," represented by f, could be completely determined and perhaps formulated over the range of investigation. Accordingly, several runs were made and, although the "true" viscosity was found by the extrapolation of the several curves to $1/L = 0$, the values of f seemed very erratic. A further and more careful investigation will be necessary to show whether the results as obtained are true and, if so, upon what conditions they depend. This work will be undertaken as soon as possible.

Figure 4 shows the curve obtained when spindles of radius 0.98 cm. and lengths varying from 2.5 to 10.2 cm. were suspended into the oil contained in a cylinder of radius 3.8 cm. The distance from the bottom of the container to the bottom of the spindle and from the top of the spindle to the surface of the oil (designated by δ) was kept at 2.0 cm. This curve is representative of those obtained.

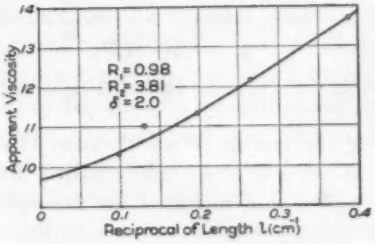

FIG. 4.

The viscosity of the oil at 20°C was found by averaging the extrapolated values for a great many such curves. It is

$$\eta = 9.67 \pm 0.10 \text{ poise.}$$

The probable error, estimated from the general appearance of the numbers used in getting the mean value, seems rather large from a precision standpoint. For the purposes, however, to which this value for viscosity was to be put, it seemed satisfactory. The difference between it and that given in Smithsonian Tables (9.86 poises) is probably in the oil itself, since no attempt was made to obtain pure oil, care being taken only in procuring enough to last during the whole investigation.

Using the value for viscosity determined as described, the correction, f, was found for a special spindle similar in dimensions to those used in measuring glass viscosities. This spindle consists of a main portion of radius about 0.47 cm. and length about 10.2 cm. supported by a stem of about 0.32 cm. The value of δ for measurements in glass is 1.50 cm. The following results were obtained when an iron spindle of these dimensions was used in castor oil:

$\delta = 1.00$ cm.	$f = 0.61$ cm.	one determination
1.25	0.64	" "
1.50	0.44	mean of 7 determinations
1.75	0.62	one determination
2.00	0.62	" "

Of the seven determinations at $\delta = 1.50$ cm., none was as large as 0.60 cm., so evidently there is some sort of minimum at $\delta = 1.5$ cm. under these conditions; $f = 0.44$ cm., is therefore the correction to be applied in the work with glass viscosities.

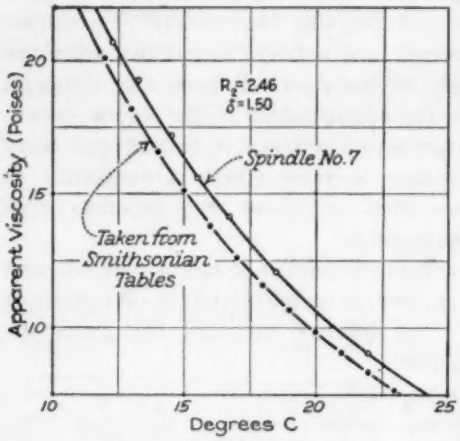

FIG. 5.—Curve for castor oil (spindle No. 7).

Temperature Run with Oil In order to try to check the rate of change of viscosity with temperature, previously used to convert all readings to a common temperature, a run was made using spindle No. 7 ($R_1 = 0.98$, $l = 7.64$), $R_2 = 2.46$ cm., and $\delta = 1.50$ cm. The oil was cooled to about 15°C by putting some ice in the surrounding water, and then allowed to approach room temperature, during the course of which time, viscosity readings were made. The results indicated a large temperature drop through the oil, so a set of thermocouples was installed on the spindle and, duplicating the conditions of the other run, the temperatures were examined. If on the basis of this, we plot apparent viscosity against the temperature of the spindle, the resulting curve is as shown in Fig. 5. The slopes on this curve are very nearly identical with those for corresponding temperatures on the other curve, plotted from values given in Smithsonian Tables.

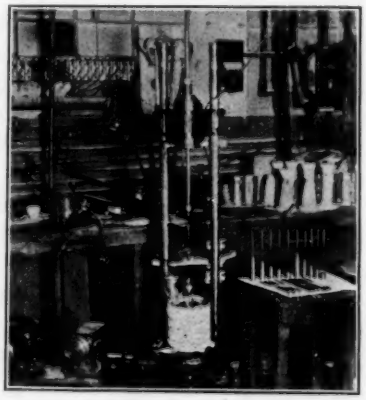

FIG. 6.

This investigation shows, rather clearly, two things: (1) The temperature of the spindle will affect, more than any other temperature, the torque exerted upon it. Therefore, if, as we go from one spindle to another, these spindles are not at the same temperature as the oil, the results will be affected by this condition, supposedly in proportion to the size of the spindle. (2) If, on the other hand, we measure the temperature by a device placed in the spindle, as was the case in the glass viscosity runs, this temperature, unless the temperature gradient is very large, will be the effective temperature of the medium.

This condition is caused by the fact that a large proportion of the total shear takes place very near the spindle.

On the basis of (1), above, it is possible that temperature variations, which were not apparent at the outer edges of the oil where the couples were located, might account for some of the erratic appearance of the results which were obtained. For if a spindle, especially one of large heat capacity were slightly warmer than the liquid, it would lower the apparent viscosity of the liquid without raising its apparent temperature unless a large amount of time were allowed. This was not done in these runs. That the method, however, described early in this paper for converting all readings to a common temperature is reliable, is shown by comparing the observed ratio between the viscosity at 18°C and that at 22°C with the same ratio on the curve from the tables. These ratios are, respectively, 1.395 and 1.390. The actual temperature range around 20°C, over which this conversion method was used, was much more confined than ±2°C.

There is still some question as to whether, due to peculiar motions of the liquid around the sharp edges of the spindle or along the bottom of the container on account of centrifugal action, the correction "f" might change slightly with a change of viscosity. Also, by the use of hemispherical ends on the spindles, a phenomenon more easily analyzed may be found. With these possibilities in mind, the investigation will be continued.

In the measurement of glass viscosities, however, in which the experimental error may be as high as 5%, the error or variations in the correction "f" would probably prove negligible.

PHYSICAL LABORATORY
CORNING GLASS WORKS

VISCOSITY MEASUREMENTS IN GLASS[1]

By Howard R. Lillie[2]

ABSTRACT

The concentric cylinder method, described in a previous paper, has been used in the measurement of viscosities in molten glass. The apparatus and method of measurement are fully described. Comparisons are made between results obtained and those of English, Stott, and Washburn. Quite good checks are found in comparisons with English and with Stott, but results obtained in comparing with Washburn indicate a difference supposedly due to his use of a variable calibrating factor. Measurements made by the use of a falling sphere give values of viscosity 25 to 50% higher than those given by the concentric cylinders in the same glasses. This may be due to the extended extrapolation of Ladenburg's correction for finite boundaries.

The importance of data concerning the viscosity of glass to the glass industry, together with the difficulties attending work in this field, have been outlined by S. English.[3] Rather complete accounts of the work on glass viscosities previous to 1925 have also been given by English, V. H. Stott,[4] and Washburn.[5]

Since the writing of these accounts, the most outstanding advances made in this field have been those of Stott, Irvine, and Turner[6,7] who have measured viscosities of glasses with apparent accuracy between the limits of 10^2 and 10^{16} poises. For viscosities between 10^8 and 10^{16} units they employed the method of placing a torsional stress upon a short cane of glass of $^1/_4$ inch diameter sealed between two other canes large enough in diameter to be little affected by the torque as compared to the smaller portion. Their values for viscosity were obtained by the use of an easily derived formula fitting the case.

For viscosities of lower values (between 10^2 and 10^4 poises) these same workers employed the velocity of a partly counterpoised sphere of platinum, having first calibrated the system against a syrup whose viscosity had been determined by the falling of free steel spheres in a container which permitted the application of Ladenburg's correction to Stokes' formula.

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[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Glass Division.) Received March 27, 1929.

[2] Physical Laboratory, Corning Glass Works, Corning, N. Y.

[3] S. English, "Effect of Composition on the Viscosity of Glass," *Jour. Soc. Glass Tech.*, **8** [31], 205 (1924).

[4] V. H. Stott, "The Viscosity of Glass," *Jour. Soc. Glass Tech.*, **9** [35], 207 (1925).

[5] E. Washburn, G. Shelton, E. Libman, "The Viscosities and Surface Tensions of the Soda Lime Silica Glasses at High Temperatures," Univ. of Illinois, Eng. Expt. Sta., *Bull.*, No. 140 (1924).

[6] V. H. Stott, E. Irvine, D. Turner, "Viscosity Measurements with Glass," *Proc. Roy. Soc.*, **108,** 154 (1925).

[7] V. H. Stott, D. Turner, H. Sloman, "The Effect of Thermal Treatment on Glass as Shown by Precise Viscometry," *Ibid.*, **112,** 499 (1926).

The results obtained by these two methods will be compared with certain of our results later in this paper.

Stott, together with Turner and Sloman[7] has also made use of another method, that of drawing a platinum wire out of glass at a measured rate, taking the mass of the attached glass as a measure of viscosity. In this connection, the object was to discover any effects caused by heat treatment and no results were stated in actual C. G. S. units.

Method In the work to be reported at this time, the method used for low viscosities (10–10^4) is that of Margules, consisting of the measurement of the torque produced on the inner of two concentric cylinders, separated by the medium, when the outer cylinder is made to rotate slowly, as explained in the preceding paper.* For higher viscosities (10^3–10^8) the same apparatus is used but instead of turning the outer cylinder at a steady rate, it is turned through a small angle and stopped. The aperiodic return of the inner cylinder or spindle toward its point of rest is then timed.

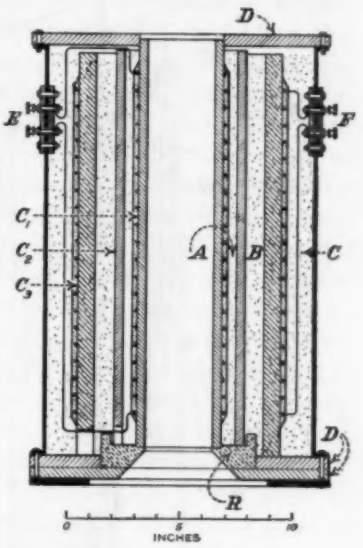

FIG. 1.

Furnaces wound with platinum and molybdenum have been used during the course of the work. The platinum furnace was constructed as shown in Fig. 1. The shell is 12 inches in diameter and the height over-all is 20 inches. The end pieces, D, are annular disks of $^1/_2$ inch transit. The ring, R, supporting the two inner cores and centering the outside core is of fire clay. The core C_1 is of alundum (3 in. I. D. x 18 in.) wound with 50-ml. commercial platinum wire with double leads reaching to binding posts at E. The platinum winding is cemented with Norton alundum cement No. 562 while the leads are protected by impervite tubing. The core C_2, also of alundum (5 in. I. D. x 18 in. shortened slightly) is merely to separate spaces A and B. Core C_3 is part of a large clay cylinder about $7^1/_2$ inch I. D. and is wound with about 60-ml. nichrome IV wire whose leads extend to binding posts at F. The space, A, is filled with granular fused magnesia of about 60-mesh. Spaces B and C are filled with sifted Sil-O-Cel. With this furnace the nichrome alone on 110 V will heat the inner core to about 700°C while with the inside closed as in actual practice (see Fig.

* "The Measurement of Absolute Viscosity by the Use of Concentric Cylinders," this *Jour.*, pp. 505–15.

2(*b*)), temperatures between 1400 and 1500°C can be readily reached by the platinum heating unit.

The molybdenum furnace now being used is the result of a great deal of experimenting with this type of furnace in this laboratory. Many fur-

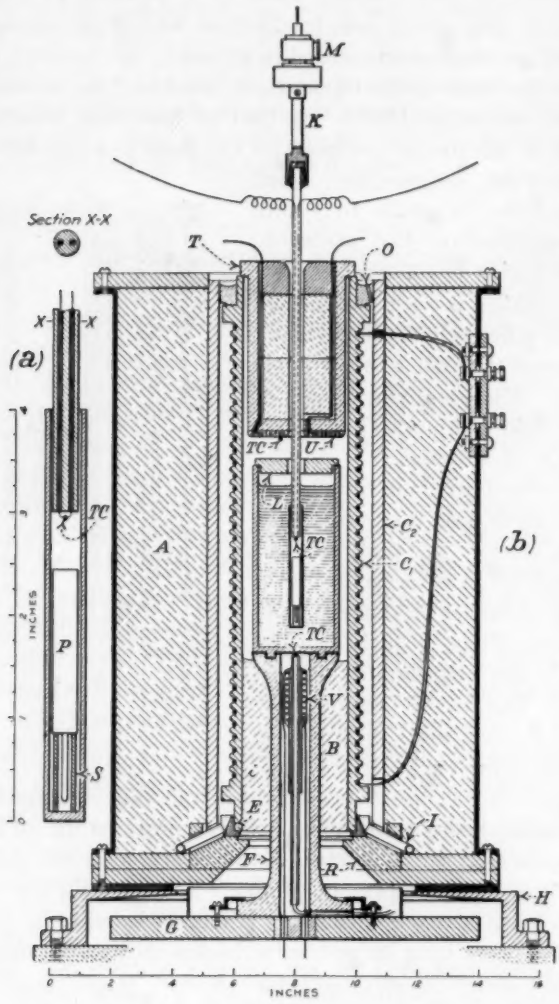

FIG. 2.

naces were built before one was obtained which had long life without an extremely reducing atmosphere in the core. The construction of the furnace is shown in Fig. 2(*b*). The furnace has an outside diameter of 12 inches and a height over-all of 20 inches. The core, C_1 ($3^1/_2$ in. I. D. x 18

in.), is a special sillimanite[8] tube molded as shown. It is wound with 50 ml. molybdenum wire which is not covered with cement. The tube is then cemented to a transit ring, *E*. The core, C_2, of alundum (5 in. I. D. x 18 in.) is then placed over it and the whole cemented rigidly to the fireclay ring, *R*, which contains the gas inlet unit, *I*, placed in grooves ground into *R*. The space between C_1 and C_2 is left open. Alundum cement is poured in at *O* after putting paper around the top inside surface of C_2 to allow for expansion slippage. A small hole is left in the cement by the insertion of a wire to allow the gas to escape during the first heating before the paper burns out. Both ends of this heating unit are then allowed to dry simultaneously. The rest of the construction is simple, consisting only of placing the heating unit into the shell and filling the space, *A*, with Sil-O-Cel. Extreme care must be taken in making the bottom seals around *E* gas-tight, for even under the best conditions the atmosphere in this furnace is slightly reducing. The gas used is a mixture of two parts of nitrogen to one part of hydrogen by volume, the rate of consumption being about 110 cubic feet of nitrogen and 55 cubic feet of hydrogen per day. A small flame is always maintained around *O*. Temperatures between 1400 and 1500°C can be obtained on 110 V when the inside is closed as in actual use for viscosity measurements, and at times when the core is practically empty 1500°C has been obtained on 140 V. The only advantage of the use of molybdenum seems to be that of rapid heating, since the cost of gas, together with the chance of shorter life due to a developed gas leak, and the crystallization of a small part of each thermocouple accompanying every run due to the slightly reducing conditions, offsets to a large degree the depreciation of platinum in a furnace of that material. The platinum furnace, however, should be given 24 hours to heat to 1450°C while due to the extremely high melting point of molybdenum, it can be brought to this temperature in about 8 hours if the gas supply is carefully regulated.

Experimental Set-up

Figure 2(*b*) shows the most recent arrangement of the apparatus for the measurement of viscosity by this method. The glass sample, consisting of a cylinder of glass usually $5^3/_4$ inches in length and $2^1/_4$ inches in diameter, is made in the blowing room by dropping the glass from a gathering iron into an iron mold, after which it is annealed. The rough end is then ground off and the sample placed into the crucible. This crucible is of sillimanite ($2^1/_2$ in. I. D. x 6 in.), being cylindrical, with a flat bottom fitted with two small lugs which fit into holes in the fireclay stand, *F*. Coarse alundum cement is placed between the stand and crucible and the latter carefully centered by rotating the table, *G*. The lid, *L*, molded of alundum

[8] All parts mentioned here as "sillimanite" were obtained from Champion Porcelain Co.

cement is then placed over the crucible and adjusted to center its opening. The furnace is next lowered into position upon the stationary casting, *H*, and then, after placing a metal cap over the lid, *L*, to prevent contamination, Sil-O-Cel is poured around the crucible to fill the space, *B*. The top piece, *T*, is then put in place and centered. This top piece is a flanged cylinder, with flat bottom, constructed of fire clay and containing two sections of insulfrax brick held, at the top, by alundum cement. There is a $^1/_2$-inch hole through the entire length of this top piece to admit the spindle. An additional platinum-rhodium heating unit in the form of a spiral is attached to the bottom of the top piece at *U*, having leads at the top as shown. Another platinum-rhodium heating coil is wound on a small sillimanite tube and inserted at *V* through a $^3/_4$-inch hole running the length of the stand, *F*. This coil has leads, which, by means of mercury reservoirs at the extreme bottom of the apparatus, allow current to flow while the table, *G*, is turning. The object of these two heating units is to make the space occupied by the crucible as nearly as possible of uniform temperature. This condition is indicated when the temperature of each of the two auxiliary thermocouples placed above and below the crucible, as shown in the drawing, is equal to that indicated by the main thermocouple inside the spindle.

Construction of Spindle

The most satisfactory spindle as yet tried for this work is shown in Fig. 2(*a*). A special sillimanite tube, $^3/_8$ in. O.D. x 4 in., as straight as possible and with one end closed flat, is used for the main portion. Into this is placed a platinum weight, *P*, of about 25 g. mass, supported by a short piece of sillimanite tubing, *S*. The stem of the spindle, consisting of a 12-inch straight length of impervite $^1/_4$-inch double bore thermocouple tubing carrying a platinum platinum-rhodium thermocouple, is then cemented into the top of the larger tube by means of a kaolin clay of high purity. The platinum weight tends to make this spindle stay directly under the suspensions, while the thermocouple gives the best approach to the effective temperature of the glass, since the greater part of the whole shear takes place near the spindle. This thermocouple is used for the actual temperature measurements, while the other two are simply used to indicate when a uniform condition is obtained. The leads of the spindle couple terminate in coiled spurs, as shown in the drawing, which, before and after viscosity measurements are made, may be caught into hooks of the same materials while temperature readings are taken. The upper end of the spindle stem, after being ground on the sides to allow the thermocouple leads to be free, is cemented into the iron connector, *K*, which in turn is attached to the suspensions through the chuck carrying the mirror, *M*. Two suspensions are mounted exactly as described in the preceding paper, in this case being of about 16 and 28 ml. steel wire.

Method of Procedure and Computation

Until the furnace temperature is near 1200°C, the spindle is allowed to hang just above the glass; at this time it is lowered into the glass slowly until the collar on the upright steel support holding it strikes the head of the viscometer, this collar having been previously set at the proper place to bring the bottom of the spindle 1.5 cm. from the bottom of the crucible. The outfit is then ready for measurements. The furnace is allowed to stay about 45 minutes at a very nearly constant temperature before viscosity readings are made. These readings consist of the deflections caused by at least two speeds of rotation in both directions, together with the time per revolution for each case, as found by a stop-watch. It is also necessary to know the distance from the mirror to the scale.

If a deflection, D, a time, t, per revolution and a scale distance, d, are observed, then as shown in the preceding paper

$$\eta = \frac{KZDt}{4\pi ECdL}$$

where K is the constant of the suspension in dyne cm./radian, Z is the correction factor to account for the straight scale, C is the spindle constant equal to

$$\frac{4\pi R_1^2 R_2^2}{R_2^2 - R_1^2}$$

R_1 and R_2 being the radii of spindle and crucible, respectively, L is the effective length of the spindle corrected for glass expansion and E is the correction for expansion of the spindle itself.

The effective length, L, of the spindle is determined as follows: To the actual measured length of the main section is added the correction f as determined by the measurements reported in the preceding paper* to account for the ends of the spindle. For the spindles used in the glass viscosity work, f was found to be 0.44 cm. Another small length is then added to $(l + f)$ for that part of the stem of the spindle which is in the glass. If the radius of this portion is R', we use

$$L = l + f + \frac{R'^2 x}{R_1^2}$$

where x is computed for 0°C from the mass of glass used, and for 350°C from its expansion coefficient between these temperatures. After the run is over, one can see on the spindle to what height the glass wet the stem and, allowing about 0.2 cm. for surface tension, an approximate x for the highest temperature attained is measured. From these various values, a closely approximated curve for L can be plotted against temperature.

Now as seen from the formula being used in connection with this method, the torque is proportional to $R_1^2\ L$ over small limits of variation of R_1. This in turn is proportional to the volume of the spindle. So as a further

approximation toward correcting the viscosity, the factor, E, equal to the ratio of the volume of a piece of sillimanite at a given temperature to the volume at 0°C, is incorporated:

$$E = 1 + 3\left(\frac{L_T - L_0}{L_0}\right)$$

This may be computed from expansion coefficient values and plotted against temperature. It is nearly a straight line with a value (for sillimanite) at 1500°C being:

$$E_{1500°} = 1.025$$

At high viscosities the method of constant rotation cannot be used. When the temperature has been lowered by successive steps to the vicinity of 1000°C, the suspension of lower constant is again used and the aperiodic motion of the spindle employed as a measure of viscosity. The expressions for this case can be derived from the differential equations for a torsional pendulum damped until the motion is aperiodic, but for this special case the following gives the same results. Consider the table turned through a small angle and the spindle returning toward its zero position. The instantaneous expression for its motion will be

$$K\theta = \frac{-4\pi\eta\Omega R_1^2 R_2^2 EL}{R_2^2 - R_1^2} = C\eta EL\left(\frac{-d\theta}{dt}\right)$$

Integrating and putting in limits

$$\eta = \frac{K(t_2 - t_1)}{ECL\log_e(\theta_1/\theta_2)} = \frac{K(t_2 - t_1)\log e}{ECL\log(\theta_1/\theta_2)}$$

By taking the length of time for the deflection to make a certain transit, *e.g.*, from 25 cm. to 15 cm. on the scale, the other factors being already known, the viscosity may be readily computed.

Softening Point Viscosity

The softening point, as defined,[9] is that temperature at which a small cane of glass, about 0.065 cm. in diameter and 22.9 cm. in length of which only a part is inside a very small furnace, will elongate on account of its own weight at the rate of 1 mm. per min. Several previously measured samples were allowed to stretch about 1 cm. and then remeasured. The checks were very close among these samples, so one example is sufficient:

Average original diameter	0.0641	cm.
Original length	22.84	cm.
Change in length	1.05	cm.

The greatest change in diameter took place between 6.5 cm. and 7.5 cm. from the top of the sample. The average change in diameter here was 0.0067 cm.

$$\text{Since } \Delta L = \frac{-L\,\Delta D}{R}$$

[9] J. T. Littleton, Jr., "A Method for Measuring the Softening Temperature of Glasses," *Jour. Amer. Ceram. Soc.*, **10** [4], 259 (1927).

the change in length over this cm. is 0.209 cm. or 0.199 of the total change in length. The rate of elongation when the hottest part is at the softening point, supposedly where the temperature is measured, is then 3.32×10^{-4} cm./cm./sec. The viscosity is given by

$$\eta = \frac{L\rho g}{3E}$$

where ρ is density, L, the length below the point being considered and E the rate of elongation in cm./cm./sec. Since, in such a small sample, surface tension plays an important part, an approximate correction was made according to Washburn's surface tension results.[10] This correction amounts to a factor of about 0.85 since surface tension holds up 0.15 part of the whole suspended mass. Then

$$\eta = \frac{0.85\, L\rho g}{3E}$$

Taking $\rho = 2.50$ and $E = 3.32 \times 10^{-4}$, η = approximately 3.2×10^{7} poises, or $\log_{10} \eta = 7.50$.

This value has been found to fit so well on the viscosity curves, that it has been used as an actual determined point in all recent runs.

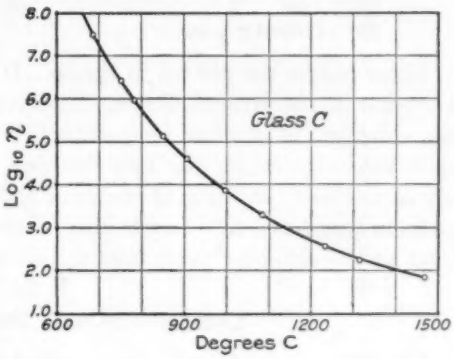

FIG. 3.

Representative Viscosity Run

To provide an example showing how results by this method are obtained and to what degree of precision these results follow a smooth curve, a complete viscosity run was made with a common soda lime glass designated as Glass "C."

The laboratory analysis of this glass follows:

	Per cent
SiO_2	72.27
$Al_2O_3 + Fe_2O_3$	0.75
CaO	8.64
MgO	0.15
$Na_2O + K_2O$	17.76
Total	99.57

Other values used later are

Softening point 686°C
Mean expansion coefficient (0–350°C) 1.026×10^{-5} per °C

Viscosity data were then obtained in the manner explained, with the following results:

[10] *Loc. cit.*, p. 53 (see footnote 5).

$R_1 = 0.4462$ cm.; $R_2 = 3.17$ cm.; $C = 2.550$

Temp.	ZDt	d	K	L	E	$\eta = 0.0312 \frac{KZDt}{EdL}$	$\log_{10}\eta$
1465°C	37.8	71.4	3.930×10^4	11.16	1.024	5.68×10	1.754
1311	121.7	"	"	10.95	1.022	1.87×10^2	2.271
1228	254	"	"	10.84	1.020	3.94×10^2	2.595
1077	1395	"	"	10.66	1.018	2.21×10^3	3.344
1077	107.8	71.5	4.912×10^5	10.66	1.018	2.13×10^3	3.328
999	342	"	"	10.58	1.017	6.81×10^3	3.833

Temp.	$\frac{t_2 - t_1}{\log \theta_1/\theta_2}$	d	K	L	E	$\eta = 0.1703 \frac{K}{EL} \frac{t_2 - t_1}{\log \theta_1/\theta_2}$	$\log_{10}\eta$
905	59.0	70.0	3.930×10^4	10.49	1.015	3.71×10^4	4.571
853	196.3	"	"	10.44	1.014	1.24×10^5	5.093
786	1280	"	"	10.37	1.013	8.15×10^5	5.911
786	99.6	"	4.912×10^5	10.37	1.013	7.94×10^5	5.900
755	292	"	"	10.34	1.012	2.33×10^6	6.368
686	Softening point					3.2×10^7	7.50

These results are plotted in Fig. 3. It will be seen that all the points lie very close to the curve as drawn. In this particular run, both methods were not employed at any one temperature, but in other runs it has been found that values given by the two methods at the same temperature check about as closely as those at the same temperature using two different suspension constants, K. It will also be noted how well the value, $\log \eta = 7.50$, at the softening point falls on the curve.

Comparisons with Results of Others

For the purpose of comparing results by this method with those obtained by other workers using various other methods, runs were made on several glasses, which were of compositions in the neighborhood of those cited by the other men. Using these glasses as a basis for interpolation, viscosity values were estimated for the exact compositions desired. The interpolations were over small ranges of composition, and no large irregularities were discovered in any data.

The Work of English[11] Two of English's glasses were considered. Their compositions, as given by him, are:

Glass no.	SiO_2	R_2O	RO	R_2O_3
10	74.59%	14.22%	10.68%	0.66%
460	74.13	13.54	9.83	2.76

By interpolation, results were obtained for three glasses of comparable compositions, which were: No. 1 of same composition as No. 10; No. 2 of same composition as No. 460, except for R_2O_3 of which only about 0.5% was present; and No. 3 the same as No. 2 except that 1.5% R_2O_3 was present. In all these glasses R_2O_3 was considered as an impurity and the other three components computed on the basis of the remainder.

[11] S. English, "The Effect of Composition on the Viscosity of Glass" (Part III), *Jour. Soc. Glass Tech.*, 9 [34], 83 (1925).

The viscosities of these five glasses, as taken from smooth curves, are as follows:

Glass no.	Logarithms of viscosities		
	1300°C	1100°C	1000°C
10	2.580	3.477	4.130
460	2.839	3.531	4.000
1	2.486	3.481	4.196
2	2.563	3.548	4.256
3	2.663	3.650	4.326

At 1300°C the viscosity given for Glass 460 is 80% higher than that for Glass 10. A comparison between Glasses 1 and 2 shows that only about

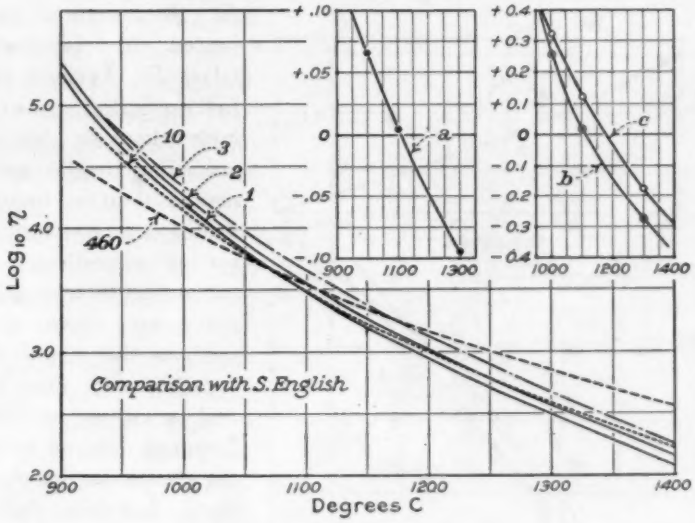

FIG. 4.

60% is due to increased R_2O_3 content, the rest being caused by the decrease in the original R_2O. This is not quite true when R_2O_3 is considered as being substituted for RO but serves to indicate that a small part of the increase is due to the change in R_2O content.

The five curves from which the figures are taken are shown in Fig. 4. It will be seen that the curves for Glasses 1 and 10 are in very close agreement, especially between 1000 and 1200°C. The small graphs in Fig. 4 represent differences. Curve "*a*," showing the difference $(\log \eta)_1 - (\log \eta)_{10}$ plotted against temperature, indicates that between 1025 and 1200°C this difference is between ± 0.05 in the logarithm, or $\pm 12\%$. Considering the fact that 5% would not be considered a large experimental error, this seems a rather good agreement. Curve "*b*" is plotted in the same way for $(\log \eta)_2 - (\log \eta)_{460}$, and "*c*" for $(\log \eta)_3 - (\log \eta)_{460}$. Apparently the point at which

these curves pass through zero difference follows approximately the point where log η = about 3.5. Glass 3 shows a slight tendency to flatten as a result of increased R_2O_3, as English found more pronouncedly in Glass 460. It may be concluded that although English's values are lower below 1100°C and higher above that temperature, the units in which his viscosities are expressed apparently check very well with ours.

Results of V. H. Stott and Co-Workers[12]

The agreement found in comparisons with results given in the more recent reports by Stott is very striking. By the same method as was described in connection with the comparison with the results of English, viscosities were found for compositions corresponding with Stott's glasses F_1, F_2, C, and E. He measured and reported the viscosities for Glass F_1, obtained by the falling-sphere method,[6] later changing his curve according to the use of a new calibrating factor, assumed to be constant (22.0) for all viscosities. Points taken directly from this new curve are shown in Fig. 5(*a*), as the single circles, together with some points and a curve, interpolated from our data on neighboring glasses, for this composition. Assuming that some error is probable in an interpolation such as has been described, the agreement seems remarkably good. At 1400°C the difference between the two curves is equivalent to 20%.

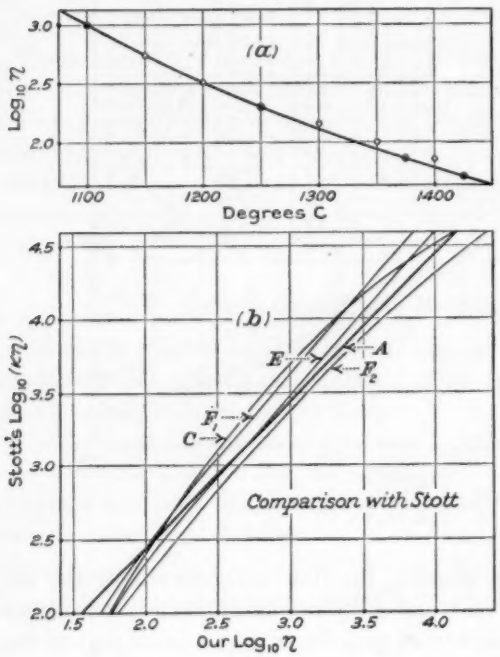

FIG. 5.

Stott also used another method for the measurement of relative viscosity ($K\eta$). This method consists of slowly drawing a platinum wire out of a crucible of glass and then measuring the amount of glass adhering to the wire. He gives curves obtained in this way for four glasses. Interpolated curves have been obtained for similar compositions, and comparisons are made in Fig. 5(*b*) in terms of Stott's log ($K\eta$) plotted against our log η. The heavy line, A, marks where the curves would be for a constant

[12] Stott, Turner, Sloman, *loc. cit.* (see footnote 7).

factor $K = 2.8$, as Stott suggests. Although K does not seem to follow the same values for all the glasses, probably because other physical properties are effective in this method, in general K increases as log η increases. For Glass F_1 in which the agreement is close, as shown in Fig. 5(*a*), the variation of K with log $(K\eta)$, between values 2 and 5 for log $(K\eta)$, is nearly linear and can be expressed by the empirical equation: $K = 1.35 \log (K\eta) - 0.45$. The value of log $\eta = 1.95$ is obtained when K is put equal to 2.8.

Results of Washburn and Co-Workers[13]

In the extensive viscosity research reported by Washburn in 1924, data were obtained on many glasses over the whole useful range of soda lime silicates. His apparatus was somewhat similar in design to that of English. Calibration was obtained by measurements made in oils and syrups previously standardized by various methods. The calibration factor obtained varied from about unity at log $\eta = 1.5$ to about 2.7 at log $\eta = 5.0$.

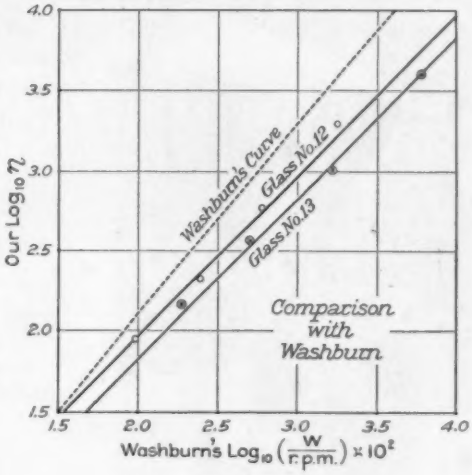

FIG. 6.

In an apparatus of this type, if viscosity is considered in terms of its fundamental definition, making it proportional to force exerted per unit shear, there is no apparent reason for the calibration factor being anything but constant unless, under various conditions, the velocity envelopes in the system shift positions, in which case the angular velocity of the revolving cylinder would not be a constantly true measure of the rate of shear near the spindle. The only conceivable cause for this happening would be that of widely varying rates of shear. Whether this could possibly have been true in Washburn's apparatus cannot be said definitely but it seems very improbable. The fact that Washburn assumed the fundamental definition of viscosity in his calibrating methods, and found thereby that in the apparatus being calibrated this definition apparently did not function in the reasonably expected way, makes it hard to point out what step in his calibrating procedure might be at fault. Whether media of very high viscosity follow the same fundamental laws as those of low viscosity, or not, it still seems that the apparent viscosity, or rela-

[13] See footnote 5.

tive resistivity to being worked, is the property sought in any research on glass viscosities.

During all of the present investigation, whenever constant rotations were used, the same series of angular velocities was employed at all viscosities, obtaining the necessary variations in sensitivity by shifting from one suspension to another. Over this narrow range of velocities, no large or consistent variations in apparent viscosity with speed have been found, and, the rate of shear being the same for all viscosities, the factors relating torque to viscosity should remain constant.

Stott has intimated that if Washburn had used a constant calibrating factor, his results would be more in accord with those obtained by others in the same field. To make a test of this, measurements were made in some glasses approximating two of Washburn's compositions and viscosities interpolated to those points as described before.

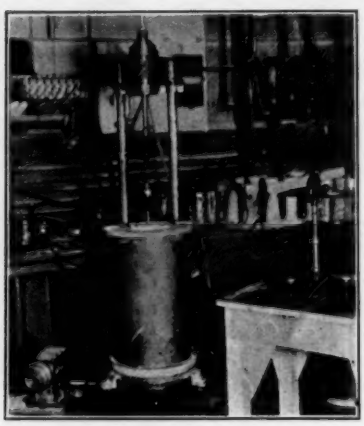

FIG. 7.

Figure 6 shows curves in which Washburn's $\log \left\{ \frac{W}{\text{r.p.m.}} \times 10^2 \right\}$ is plotted for the two glasses (Nos. 12 and 13) against our values for $\log \eta$ interpolated for the same compositions. The values for $\log \left\{ \frac{W}{\text{r.p.m.}} \times 10^2 \right\}$ were read from Washburn's graph, for the viscosities listed in his tables.

It can be readily seen that for a given glass there is no consistent deviation from the direct proportion (slope = unity). The values found from these curves, for the calibrating factor, are 0.86 for Glass 12 and 0.67 for Glass 13. The difference is probably due to small variations in the sizes of crucible and stirring member, the friction of the moving parts, or other extraneous effects.

Comparison with Falling Sphere Method

Another method in common use for measuring glass viscosities is that in which a counterpoised platinum sphere is allowed to fall through the glass and its velocity measured. Results for two glasses, previously examined by the concentric cylinder method, were obtained in the following manner. A sphere of platinum-iridium about 1.25 cm. in diameter was supported from a balance beam, adjusted to neutral equilibrium, by means of a platinum-rhodium wire. The arrangement of all parts inside the furnace, except for the substitution of the sphere for the spindle, was exactly as shown in Fig. 2(*b*). Using various amounts of

mass on the opposite end of the beam, the corresponding velocities of the sphere were then measured. These velocities were between ± 0.05 cm./-sec. Plotting velocity against the counterpoising mass gave in each case a straight line, from the slope of which the viscosity could be computed. In this work the correction for finite boundaries, given by Ladenburg,[14] was used.

In the first comparison run, the check between the two methods was apparently about $\pm 10\%$ with the exception of a value of 40% high for the sphere at $\log \eta = 2$. In succeeding runs, however, the checks have not been as good, the viscosity given by the sphere being consistently high. The following table gives the average of comparisons made recently:

$\log_{10} \eta$ Concentric cylinders	Falling sphere	Difference (%)
2.00	2.18	51
2.50	2.66	45
3.00	3.14	38
3.50	3.61	29
4.00	4.09	23

There is some question as to whether Ladenburg's correction factor (1.70 in this case) can rightly be applied when the radius of the sphere is $^1/_5$ that of the crucible; also whether, under the peculiar conditions surrounding measurements of high viscosities at high temperatures, the sphere is as good a measure of true viscosity, independent of other properties, as the concentric cylinders.

It may be noted that if a calibrating factor, dependent on the falling sphere results, had been assigned to the concentric cylinders, the comparison with Stott's results, obtained also by the sphere, would show a very close agreement. On the other hand, although the curves given in connection with the comparison with Washburn would be slightly raised so as to cross his calibration curve within the range of measurement, the general appearance of them would not be changed. Moreover, the falling sphere results would seem to indicate a lessening of the factor for the cylinders with an increase of viscosity, while Washburn's calibration curve indicates the opposite variation.

Acknowledgments In conclusion, the writer wishes to express his appreciation to J. T. Littleton and G. V. McCauley for their continued interest and helpful suggestions during the course of this work; also to Hartford-Empire Co., who sponsored part of the work.

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[14] R. Ladenburg, "The Influence of Boundaries on the Velocity of a Sphere in a Viscous Fluid," *Ann. d. Phys.*, **22**, 287; **23**, 447 (1907).

VOLATILITY OF SELENIUM AND ITS COMPOUNDS IN THE MANUFACTURE OF RUBY GLASS[1]

By J. B. Krak

ABSTRACT

The volatility of selenium in making selenium ruby glass has been studied. About 75% of the selenium added to the batch was lost by volatilization. Sodium selenite and barium selenite were stable at 950°C and are probably stable at higher temperatures. Regardless of whether selenium or the compounds studied are used, the resulting glass contains about equal amounts of selenium. Methods of preparing sodium and barium selenites are described. An outline is given of an analytical procedure by which selenium is determined in glass.

Introduction

Probably never in history has the production of colored glass reached present day proportions. This is due to the heavy demand for colored table settings, lamp bases, lamps, colored automobile lenses, and traffic signal glass. There is also a marked revival of interest in cathedral glass.

Colored glasses may be divided into two groups: (1) coloring substances in true solution and (2) coloring material in a colloidal state. There is no sharp line of demarcation between these two classes.

Colors of short wave-length, up to greenish yellow, belong to the first class. These are produced by manganese, cobalt, copper, and uranium (either alone or in combination) through formation of metal silicates. They are best obtained under oxidizing conditions, *e.g.*, by the use of alkali metal nitrates.

Colors of medium wave-length, yellow and orange, may be produced by cadmium sulphide, antimony sulphide, sulphur or the like, without the addition of either oxidizing or reducing agents.

The colors of the longest wave-lengths are produced by gold, copper, or selenium in the elemental state. These are obtained in the glass by reducing agents such as bone ash, tartaric acid, stannous oxide, etc.

Glasses of the first class, up to the yellows, are not difficult to produce. The depth of the color varies directly with the amount of coloring material added, subject somewhat to fire conditions. When these are controlled, results do not vary much from day to day.

Yellow glass is quite difficult to control. Besides being sensitive to fire conditions, the color depends to some extent on the heat treatment of the glass; glass colored by sulphur deepens in color on reheating.

Red glass is even more dependent on heat treatment. When it is cooled rapidly, red glass may not show any or only a faint color. Upon reheating this glass to near the softening point it "strikes color" and this color

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Glass Division.)

becomes deeper, the longer it is kept at a suitable temperature. In the vernacular of the glasshouse this is called "flashing."

A distinction must be made between flash ruby and pot ruby. The latter does not need to be reheated to the softening point to show ruby color. In certain batches (which to a large extent have been kept secret) the red color appears even when the glass is cooled rapidly. Glassmakers call such glass "pot ruby." The color depth of such glass can be further increased by flashing.

In contrast with copper ruby, known in antiquity, and gold ruby, known as early as 1650 (Kunckel), selenium ruby is of recent origin. There is no record of it being made prior to 1891.[2]

The main difficulty connected with the use of this element is its volatility. When heated to 682°C, it volatilizes completely.[3] At this temperature the reaction between the batch ingredients is just beginning and it is obvious, therefore, that its loss must be considerable.

Objects of the Investigation

The objects of this investigation were:

(1) To determine the amount of selenium lost in making ruby glass.
(2) To investigate conditions producing pot ruby.
(3) To determine whether the use of selenium compounds decreases the loss of selenium.

Nature of the Selenium Color

The literature does not give a satisfactory explanation of the nature of the selenium color. Fenaroli[4] states that selenium glass high in alkali, made under strongly reducing conditions, has a chestnut color resembling that of a water solution of alkali-polyselenide and contains polyselenides in true sôlution. He adds that in more acidic glasses, resembling the commercial types, and under moderately reducing conditions part of the alkali selenide is dissociated with the formation of elementary selenium, causing the familiar ruby color.

Treadwell[5] states that the red color is due to colloidal selenium, and points out the similarity in color between selenium ruby glass and a colloidal solution of selenium in water.

Glassmakers know that the depth of the selenium color is not solely dependent on the amount of selenium present in glass. Flashing ruby glass appears to favor the separation of colloidal selenium. The longer the glass is flashed, the deeper the color becomes until the particles become

[2] "Selenium," F. Welz, Ger. Pat. 63,558, *Berichte*, **25,** 819 (1892). "Selenites and Selenates," Ger. Pat. 74,565, *Berichte*, **27,** 777 (1894).

[3] This is the average of figures published by Troost (664°C) and Berzelius (700°C).

[4] Fenaroli, *Kolloid-Z.*, 55–58 (1915).

[5] Treadwell, *Keram. Rundschau*, **20,** 220–21 (1912).

visible and opacity ensues. Glass low in selenium when flashed longer than glass high in selenium may show a deeper color. Fenaroli believes that only a small amount of the total selenium in glass is dissociated, and takes part in the coloration of the glass. He states that selenium is partly present as selenide and that upon solution in hydrofluoric acid hydrogen selenide is formed. No data are shown to prove this.

Just why certain batches give flash ruby and others pot ruby has never been satisfactorily explained. It is known that the amount of selenium in the glass is not the deciding factor. Experiments have shown that a glass containing 0.4% selenium became light amber on cooling and had to be flashed to develop the ruby color. On the other hand, glass made with a different batch, containing 0.2% selenium, was ruby from the pot. It is probable that the viscosity and the rate of setting affects the developing of the proper red color in glass. This was studied in considerable detail in the case of gold ruby by Zsigmundy. The selenium particles probably collect around nuclei serving as centers of growth which become large enough to cause a red color.

When the amount of selenium in a pot ruby formula is decreased, the color intensity does not decrease in like proportion. Below a certain minimum, however (varying with different formulas), the pot ruby becomes a flash ruby, that is, it shows an amber color and must be reheated to the softening point to develop the ruby color.

The writer's experiments and experience in the glasshouse have led him to the conclusion that selenium does not enter into combination with the other batch ingredients. What does not volatilize during the melting process remains entrapped in the molten glass as a vapor in an extremely fine state of division. Upon rapid cooling this fine state of division persists in glasses of low fluidity and of rapid setting properties. In these the selenium molecules do not have the opportunity to condense into particles even of colloidal dimensions. Hence, the glass assumes the amber color due to sulphur added as cadmium sulphide. Upon reheating the glass to the softening point the selenium is given time and opportunity to collect into particles of colloidal size. If kept at this temperature long enough the particles will grow so large as to cause opacity. If such opaque glass is subsequently heated to complete fusion the selenium again enters into the vapor phase, and upon rapid cooling again yields an amber-colored glass that can be flashed to produce ruby color.

If our theory is correct, the difference between pot ruby and flash ruby (assuming that both contain the same quantity of selenium) becomes a difference in the viscosity and the rate of setting of the glass; in other words, it becomes dependent on the chemical composition. A fluid, slowly setting glass will give pot ruby; a highly viscous, rapidly setting glass gives a flash ruby.

We have found that if the selenium in glass falls below a certain amount, even a slowly setting, very fluid glass will not show a red color unless it is kept at the favorable temperature for some time. It was found that glasses containing as little as 0.08% selenium can still be flashed and give a good ruby color. The lowest limit has not been investigated. Evidently the coloring power of colloidal selenium is quite strong.

Loss of Selenium to Glass Industry

In 1926, 114,307 lbs. of selenium valued at $438,000 were produced in the United States.[6] Assuming that one-half of this amount was used for the manufacture of glass, and that one-half of this quantity was lost by volatilization, it can be conservatively estimated that the loss thus suffered by the glass industry is well over $100,000 annually.

But this is not the only source of loss. Many glassmakers cannot stop to flash their ware. Mass production of automobile lenses cannot proceed if every one has to be flashed; a large sheet of cathedral glass is difficult to flash evenly. In these branches only pot ruby can be used profitably and when the glass turns amber it means a considerable loss. Since ruby batches contain zinc oxide at 8 cents per pound, selenium at $1.90, and cadmium sulphide at $1.40, the loss of a batch is a serious matter.

If a batch that has been previously given pot ruby turns amber or colorless, it is due to excessive volatilization of selenium. This, in turn, may be due to too high a temperature or too long a heating period. Selenium is fired out rapidly above 1400°C regardless of whether it is added as sodium or barium selenite, or as metallic selenium.

To decrease the loss of selenium it has been proposed to use sodium selenite or barium selenite in the belief that as these compounds of selenium are more stable at glassmelting temperatures they will not release the selenium until the batch is completely melted. We have found that this is not the case, and that no saving of selenium is effected.

Experimental Sodium selenite and barium selenite were prepared and heated to 950°C. At this temperature sodium selenite is a liquid, and is somewhat volatile. Barium selenite remains a solid and shows only a slight sintering. Samples, after being kept at 950°C for 15 minutes, showed the following composition:

	(%)
Sodium selenite: theoretical Se	= 45.7
Before heating: Se	= 45.5
After heating to 950°C: Se	= 43.8
Barium selenite: theoretical Se	= 29.9
Before heating: Se	= 30.2
After heating to 950°C: Se	= 29.4

[6] *Mineral Resources of the U.S.*, 1926.

These results indicate that there is some ground for the belief that in these compounds we have a means of introducing selenium that will decrease the loss of this element.

Preparation of Sodium Selenite and Barium Selenite

This was done as follows: (1) solution of metallic selenium in concentrated nitric acid, using about 150 cc. HNO_3, specific gravity 1.38, to 100 g. of selenium; (2) evaporation to dryness; (3) solution of the residue in water; (4) addition of sodium hydroxide; (5) evaporation to dryness.

Sodium selenite is very hygroscopic.

Equations

(*a*) $Se + 2HNO_3 = H_2SeO_3 +$ nitrogen oxides

(*b*) $H_2SeO_3 + 2NaOH = Na_2SeO_3 + 2H_2O$

Barium Selenite

Steps 1, 2, and 3 as above; (4) addition of barium hydroxide; (5) filtration of insoluble barium selenite. Barium selenite is not hygroscopic.

Equations

(*a*) As above

(*b*) $H_2SeO_3 + Ba(OH)_2 = BaSeO_3 + 2H_2O$

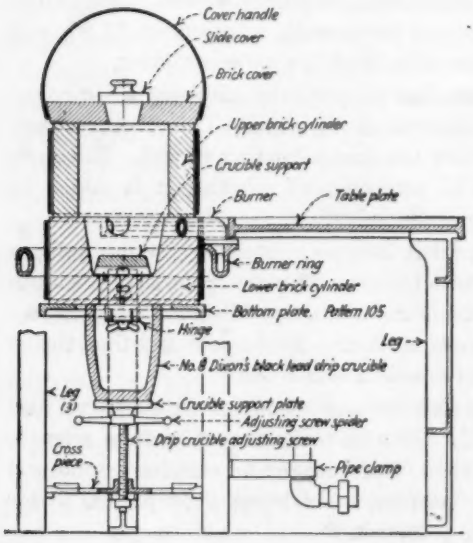

FIG. 1.—Regular melters.

Three experimental melts were made, using the same batch, and equal amounts of selenium (1) as metallic selenium, (2) as sodium selenite, (3) as barium selenite.

The furnace used was a No. 3 melter furnished by the American Gas Furnace Company, having a one-inch thermocouple hole. The temperature was measured with a pyrometer. The batch was melted in a fireclay crucible with closely fitting cover. About 1450 g. of glass were produced.

The glass was melted at temperatures ranging from 1310 to 1380°C for eight hours. It was poured into a metal pan having a thin layer of fine sand on the bottom. The pan was transferred to an electrically heated annealing furnace (510°C) and was cooled for 15 hours.

The sand was scraped off the bottom of the slab leaving the surface rough. The upper surface showed a fine polish.

Method to Determine Selenium in Glass

Transfer 5 g. of finely powdered glass to a platinum dish, moisten with water, add 25 cc. HNO_3 (concentrated), followed by 50 cc. of HF (48%). Evaporate on a steam bath with frequent stirring. Repeat the operation using 10 cc. HNO_3 and 20 cc. HF and evaporate to dryness.

Add 75 cc. H_2O (cold) and 20 cc. HCl (concentrated). Stir until all soluble matter is dissolved. Filter and wash with (cold) 10% HCl. The volume of the filtrate should not exceed 175 cc. Add 150 cc. HCl (concentrated), and gas with SO_2. Filter on a perforated porcelain crucible, wash with 3% HCl, and finally with water. Dry at 100°C and weigh. Ignite and reweigh.

To the filtrate add 250 cc. H_2O, almost neutralize with NH_4OH, and again gas with SO_2. This will precipitate any tellurium present. This element was never found in these experiments.

Obviously no scientific accuracy can be expected from melts made under the conditions described. Yet, the experiments more closely duplicate actual glasshouse conditions than if they had been conducted with greater precision. While the results obtained may not be absolute, they have relative values.

It is also realized that the method of analysis is not unassailable. If selenides are formed, they may escape oxidation by the nitric-hydrofluoric acid mixture, and pass off as selenium fluoride. Lack of time has prevented investigating this matter. The only check on the accuracy of the method was made by analyzing a ruby glass according to the method described. Then the analysis was repeated with a known quantity of sodium selenite added to the platinum dish containing the sample, previous to adding the nitric and hydrofluoric acids. The selenium was completely recovered under these conditions, showing that it is not volatilized if present as selenite.

Summary of Experiments

TABLE I

VOLATILITY OF SELENIUM

Expt. no.	Selenium added to batch A (g.)	Selenium in glass (Calculated) (%)	Selenium in glass (Found) (%)	Selenium lost (%)	Pot color of glass
1	12	0.83	0.18	78	red
2	11	0.76	0.18	76	red
3	10	0.69	0.18	74	red
4	8	0.55	0.15	73	amber*
5	6	0.41	0.14	66	amber*

* Flashing brought out the red color.

Batch A	Grams	Calculated glass composition	(%)
Sand	1000	SiO_2	69.00
Soda ash	400	Na_2O	17.03
Zinc oxide	80	ZnO	5.52

TABLE I (*Continued*)

Batch A	Grams	Calculated glass composition	(%)
Borax	80	B_2O_3	5.13
Boric acid	80		
Bone ash	20	CaO	0.74
		P_2O_5	0.63
Cadmium sulphide	16	CdS*	1.11
Selenium	(see table)	Se	See table

* Assumed to remain unchanged, to simplify calculation

TABLE II

RELATIVE VOLATILITY OF SELENIUM, SODIUM, AND BARIUM SELENITE

Expt. no.	Selenium added to Batch B (g.)	Selenium in glass (%)	Pot color of glass
6	6.75	After 3 hrs. at 1350°C, 0.18	Amber*
		After 5 hrs. at 1350°C, 0.14	
		After 7 hrs. at 1350°C, 0.13	
7	6.75 (added as Na_2SeO_3)	After 3 hrs. at 1350°C, 0.15	
		After 5 hrs. at 1350°C, 0.14	
		After 7 hrs. at 1350°C, 0.12	Amber*
8	6.75 (added as $BaSeO_3$)	After 3 hrs. at 1350°C, 0.15	Amber*
		After 5 hrs. at 1350°C, 0.13	
		After 7 hrs. at 1350°C, 0.13	

* Flashing brought out the red color

BATCH B

	(Grams)
Sand	1000
Soda ash	150
Carbonate of potash	150
Zinc oxide	80
Barium carbonate	20
Borax	150
Cadmium sulphide	15
Stannous oxide	10
Tartaric acid	10
Selenium	(see table)

Summary of Results

(1) Figures show that about 75% of the selenium added to the batch was lost by volatilization. This amount varies with batches of different compositions.

(2) Changes in the amounts of selenium added to the batch do not give corresponding changes in the glass.

(3) In the glass made according to Batch A, pot ruby turns to flash ruby when the amount of selenium drops below 0.18%.

(4) In the glass made according to Batch B the amount of selenium remaining in the glass is the same, regardless of whether it is added as metallic selenium, sodium, or barium selenite.

(5) Since no saving of selenium is made by the use of sodium or barium selenite the high prices of these materials make their use prohibitive.

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PERTH AMBOY, NEW JERSEY

Additional References

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EFFECT OF SOLUBLE SALTS ON THE PROPERTIES OF ENAMELS[1]

By R. R. Danielson

ABSTRACT

Enamels, in common with other types of glasses, are more or less soluble in water, depending on their compositions. The nature and quantity of salts dissolved from the enamel glass during milling have a very definite bearing on the suspension, workability, and other properties of the enamel, such as pitting and crawling.

Those enamels which produce mill liquors which are excessively alkaline have very poor floating qualities. The ratio of free alkali to boric oxide dissolved from the enamel frit is an important factor in the flotation properties of the enamel.

The poor floating powers of certain enamels can be corrected by the addition of suitable electrolytes. The kind and quantity of salts dissolved from the frit will determine the selection of the proper electrolyte. Enamel compositions having minimum solubility for good suspension and other properties are given.

The value of an enamel clay cannot be determined by floating the clay in water. Tests must be made with the clay in the type of enamel with which it is to be used.

Any studies on the effect of aging of enamels on their working properties must give consideration to the constitution and quantity of the individual salts dissolved from the enamel frit, and to the action of carbon dioxide in neutralizing part of the free alkali.

Introduction

The effect of soluble salts on the properties of enamels may not appear to be a subject of great importance to those familiar with the common use of borax for "setting up" ground coats, and with the occasional use of magnesium sulphate for tempering cover enamels. This does not take into consideration, however, those salts which are dissolved from the frit during the milling and aging of the enamel. In studying enamel glasses of widely varying compositions, our limitations in knowledge of this subject soon become very apparent. It becomes evident that the subject is of fundamental importance, and that a more thorough study of the effect of soluble salts on the properties of enamels would also help to clear up some of the problems involving aging and workability of enamels which have not been considered in that connection.

Review of Literature

It has long been recognized that all glasses are more or less soluble in water, and a great amount of data is available on the solubility of glasses of the type used for containers,[2] glazing, and chemical ware.[3] Mayer[4]

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Enamel Division.) Received March 18, 1929.

[2] K. L. Ford, "The Weathering of Glass Containers," *Jour. Amer. Ceram. Soc.*, **5** [12], 837 (1922).

[3] See International Critical Tables, Vol. II, p. 107, "Chemical Durability of Glasses."

[4] Arthur Mayer, "A Peculiar Property of Some Glazes," *Trans. Amer. Ceram. Soc.*, **11**, 369 (1909).

has discussed the effect of composition of a glaze on its floating properties. This work is more closely related to the problems involved in enamels, since the glazes he discussed were of the borosilicate type requiring fritting of part of the glaze ingredients. Ashley[5] in his pioneering work on the control of colloidal matter in clay gave a very thorough discussion of the regulation of suspension of glazes and engobes. While both Mayer and Ashley presented their work about twenty years ago, their conclusions on the regulation of glaze suspensions are particularly applicable to the problems involved in the flotation of wet-process enamels, as pointed out by Staley[6] and by Poste.[7]

More recently enamelers have begun to give attention to the solubility of enamel frits during milling, and the work of Cook[8] is of particular interest. Cook has shown that the principal salt dissolved from an ordinary enamel was borax with smaller amounts of sodium carbonate, sodium sulphate, and sodium chloride. He also established that increase in time of milling increases the solution of boron and sodium salts from the enamels.

There has been need for continued work on this subject with particular reference to enamels of varying compositions, since it might be assumed that enamels would show varying solubility depending on the composition of the frit. With this in mind, solubility data on various types of enamels have been obtained.

Solubility of Some Typical White Enamels for Sheet Steel

The results of the solubility studies on a series of ten white enamels for sheet steel are shown in Table I. These enamels were smelted in a rotary smelter in batches of about 40 pounds of raw material. Ten pounds of each frit were milled with 5% of clay, 6% of tin oxide, 0.25% of magnesium carbonate, and 42% of water for approximately $2^1/_2$ hours. This grinding brought the enamel to a degree of fineness so that 275 cc. of wet enamel washed through a 150-mesh screen left a residue of 2 to 4 grams. The enamels were allowed to settle for 24 hours, when 50 cc. of the mill liquor was drawn off for analysis. The total free alkali and boric oxide were determined by the method given by Cook,[8] except that tenth-normal solutions of hydrochloric acid and sodium hydroxide were used for the

[5] H. C. Ashley, "Control of Colloidal Matter in Clay," Bur. Stand., *Tech. Paper*, No. 23, p. 102.

[6] H. F. Staley, "Materials and Methods Used in the Manufacture of Cast-Iron Wares," Bur. Stand., *Tech. Paper*, No. 142, p. 75.

[7] E. P. Poste, "Analysis of Suspension of Enamels," *Jour. Amer. Ceram. Soc.*, **8** [4], 232 (1925).

[8] H. L. Cook, "Solubility of Enamel Frit in Mill Water," *Jour. Amer. Ceram. Soc.*, **10** [5], 339 (1927).

TABLE I

COMPOSITION AND SOLUBILITY OF SOME TYPICAL SHEET STEEL ENAMELS

Enamel	Percentage melted composition								Solubility (10 cc. mill liquor contained in grams)				
	Feldspar	Flint	Boric oxide	Sodium oxide	Cryolite	Fluorspar	Sodium antimonate	Zinc oxide	Sodium oxide	Boric oxide	Equiv. borax	Excess sodium oxide	Sodium oxide-boric oxide ratio
1	30	20	11.7	8.3	15.0	7	8	0.0	0.0241	0.0161	0.0439	0.0170	1.50
2	30	20	11.7	8.3	12.5	7	8	2.5	0.0252	0.0164	0.0447	0.0180	1.53
3	30	20	8.7	8.3	12.5	7	8	5.5	0.0158	0.0100	0.0273	0.0114	1.58
4	20	30	8.7	8.3	12.5	7	8	5.5	0.0195	0.0100	0.0273	0.0151	1.95
5	30	23	8.7	8.3	12.5	4	8	5.5	0.0140	0.0099	0.0270	0.0096	1.45
6	23	30	8.7	8.3	12.5	4	8	5.5	0.0148	0.0106	0.0289	0.0101	1.40
7	30	21	8.7	10.3	12.5	4	8	5.5	0.0133	0.0078	0.0212	0.0099	1.70
8	21	30	8.7	10.3	12.5	4	8	5.5	0.0136	0.0089	0.0242	0.0097	1.53
9	27	21	8.7	10.3	12.5	4	8	8.5	0.0146	0.0089	0.0242	0.0107	1.64
10	21	27	8.7	10.3	12.5	4	8	8.5	0.0149	0.0100	0.0273	0.0105	1.49

titrations. The use of the weaker titrating solutions is especially recommended, in order to reduce errors, when mill liquors containing smaller quantities of soluble salts are to be titrated.

In the range of compositions presented, the effect of increased boric oxide on the solubility of the frit was very pronounced. The replacement of a part of this boric oxide by zinc oxide had a decided effect in reducing the solubility of the enamel as shown in Enamels 3 and 4. The replacement of a part of the silica by sodium oxide, as in Enamels 5 and 7, slightly decreased the solubility of the enamel. This might seem to be at variance with expected results, until it is recalled that in the range of compositions with which we were working, this increase in sodium oxide at the expense of silica materially softened the enamel and made it much more fluid in smelting, so that a more thorough combination of the several ingredients was brought about. This improved the stability of the frit, thus lowering its solubility during the milling action. The reversal of the flint and feldspar in several cases is also of interest. It is quite evident that the additional alumina obtained from the feldspar, when the contents of flint and feldspar were reversed, also helped to stabilize the enamel.

The boric oxide content of Enamel 7 is approximately half that of Enamel 1, and the free alkali was reduced in this proportion. On very slow drying, Enamel 1 tended to throw out crystals of borax and other soluble salts, which on burning showed up as pits. Enamel

7 and others with a similar small amount of soluble salts in the mill liquor have shown freedom from this crystallization and pitting under the slowest drying which might be encountered in shop practice.

Relative Solubility of Enamels under Laboratory and Plant Conditions

While these laboratory tests give results which are truly comparative, as proved by the number of check results obtained, it would be expected that the solubility under commercial preparation would be magnified. Such factors as the longer time required for grinding large charges of enamel and the heating up of the charge during grinding would naturally be expected to increase the solubility. This is very well shown in Table II giving the solubility data obtained on Enamel 7, milled under the laboratory conditions previously described, and under plant conditions. In the latter case, a 1000-lb. charge was milled for 8 hours.

TABLE II

EFFECT OF MILLING CONDITIONS ON SOLUBILITY OF ENAMEL 7

	Laboratory milling 10-lb. charge	Commercial milling 1000-lb. charge
Time of grinding (in hours)	$2^1/_2$	8
Fineness test, grams of residue on 150-mesh screen (275 cc. enamel)	3.50	2.75
Sodium oxide, g. per 10 cc. mill liquor	0.0130	0.0370
Boric oxide, g. per 10 cc. mill liquor	0.0078	0.0150
Borax, g. per 10 cc. mill liquor	0.0211	0.0409
Excess sodium oxide, g. per 10 cc. mill liquor	0.0096	0.0304
Sodium oxide-boric oxide ratio	1.67	2.47

It will be noted that the solubility in terms of sodium oxide has almost tripled while that of the boric oxide has approximately doubled. These quantities of oxides would be equivalent to approximately 0.44% of combined borax and sodium hydroxide added to the mill charge so that the importance of the solubility of the frit on the flotation of the enamel can be estimated.

Careful studies at this particular plant, however, show that a white enamel does not begin to give difficulty with crystallization and pitting until the soluble salts are about twice the quantity of those indicated for Enamel 7 when milled under plant conditions. In other words, this enamel would be absolutely free from this difficulty, even under their slow drying conditions, most of the white ware being dried without heated drier accommodations. There are commercial enamels which develop at least three times the solubility of Enamel 7. Such enamels give considerable difficulty with pitting due to the crystallization of borax in drying, and this at times becomes a very serious shop problem. Various methods for overcoming pitting of enamels have been discussed by the author in another publication.[9]

[9] R. R. Danielson, "Some Observations on the Pitting of Wet-Process Enamels," *Enamelist*, **6** [1], 26 (1928).

Solubility of Some Wet-Process Cast-Iron Enamels

In order to obtain some data on the solubility of wet-process enamels for cast iron, Enamels 11 and 12, of the melted composition shown in Table III, were studied.

TABLE III

PERCENTAGE MELTED COMPOSITION OF WET-PROCESS CAST-IRON ENAMELS

	Enamel 11	Enamel 12
Feldspar	15.4	15.4
Flint	14.6	14.6
Boric oxide	9.3	9.3
Sodium oxide	8.9	5.9
Cryolite	10.4	10.4
Fluorspar	3.2	3.2
Lead oxide	16.8	19.8
Barium oxide	8.0	8.0
Zinc oxide	8.2	8.2
Sodium antimonate	5.2	5.2
	100.0	100.0

These were milled with 3% of clay, 5% of tin oxide, and 40% of water. The analysis of the mill liquor from each enamel is given in Table IV.

TABLE IV

ANALYSIS OF MILL LIQUORS OF ENAMELS 11 AND 12

	Enamel 11	Enamel 12
Sodium oxide, g./10 cc. of mill liquor	0.0195	0.0167
Boric oxide, g./10 cc. of mill liquor	0.0150	0.0160
Equivalent borax, g./10 cc. of mill liquor	0.0410	0.0436
Excess sodium oxide, g./10 cc. of mill liquor	0.0129	0.0091
Sodium oxide-boric oxide ratio	1.30	1.05

It is interesting to note that these enamels show relatively high solubilities as compared with the sheet steel enamels, 1 to 10, both types having about the same percentages of sodium oxide and boric oxide in the frit. This increased solubility in the case of the cast-iron enamels is undoubtedly due to the effect of lower silica and alumina and the use of lead and barium oxides. These changes in composition tend to increase the water solubility of a glass according to many investigators.[3] These enamels, however, show excellent suspension in spite of the low clay content. The enamels are interesting in that boric oxide and sodium oxide are present in the mill liquors in approximately equal quantities, and the estimated borax is particularly high.

Effect of Excess Borax on the Crawling of Enamels

In order to determine the effect of additional borax on the floating and working properties of these enamels, they were again milled according to the batches previously mentioned, but with the addition of 0.50% of borax to the mill batch. Both enamels had excellent floating qualities but showed an increased tendency to crawling during the firing of the enamels on the castings, especially on the application of heavy coats. This same ten-

dency has previously been noted by the author[10] in enamels of this type containing high boric oxide as a constituent of the frit. It was assumed at that time that this crawling was caused by the viscosity imparted to the enamel by high boric oxide, but it is more probable that the solution of borax from the frit during grinding was the underlying cause.

The phenomenon of crawling in these instances is probably due to the shrinkage and high surface tension of the free borax on fusing, and is similar to the familiar shrinkage and balling up of a borax bead. The enamel, on castings which were removed from the furnace before fusion took place, had developed cracks, in some instances $^1/_4$ inch wide. Seger[11] has cited a similar case in the production of crackled glazes by the introduction of hydrated alumina in the raw glaze. Why ground coats do not show this crawling is not thoroughly understood in the lack of data on their solubility in milling. Such factors, however, as coarser grinding, and somewhat lighter application common to ground coats, as well as the difference in surfaces to which ground coats and white enamels are applied, undoubtedly have a bearing on the difference in behavior.

Solubility of Some Special Enamels

In order to obtain further solubility data on low boric oxide enamels, several enamels of a type not common to commercial practice were included in this study. These are shown in Enamels 13 to 15 (Table V) with the results of the analyses of the mill liquors. While these enamels may not be suitable for commercial use, they give valuable information on the relations of composition and solubility.

TABLE V

COMPOSITION AND SOLUBILITY OF SOME SPECIAL ENAMELS

	Percentage melted composition								Analysis of mill liquor (g. per 10 cc.)				
Enamel	Silica	Alumina	Boric oxide	Sodium oxide	Cryolite	Sodium antimonate	Lead oxide	Fluorspar	Sodium oxide	Boric oxide	Equivalent borax	Excess sodium oxide	Sodium oxide-boric oxide ratio
13	55	4	4	16	4	8	6	3	0.0277	0.0036	0.0098	0.0261	7.7
14	57	2	4	16	7	8	0	6	0.0198	0.0035	0.0095	0.0183	5.6
15	55	2	8	16	8	8	0	3	0.0130	0.0053	0.0144	0.0107	2.5

These enamels were milled with 3% of clay, 8% of tin oxide, 0.25% of magnesium carbonate, and 42% of water. All of these enamels settled badly after milling and difficulty was encountered in spraying them on the

[10] Danielson and Reinecker, "Wet-Process Enamels for Cast Iron," Bur. Stand., *Tech. Paper*, No. 246.

[11] Seger's Collected Writings, Vol. 2 p. 733.

ware. It was thought that this difficulty might be due to the low clay content. Increasing the clay additions to 10% and substituting other clays was of no benefit, and some clays actually gave greater difficulty than the clay used throughout this work.

In examining the solubility data of the enamels for a possible explanation of the differences in floating properties of Enamels 1 to 12 and Enamels 13 to 15, the ratio of sodium oxide to boric oxide in the mill liquors is of interest. In the first group this ratio varies between 1.05 and 1.70, while in the second group the ratio varies from 2.5 to 7.7. In other words, for enamels with satisfactory floating properties, the excess of sodium oxide over that which can be neutralized by the boric oxide is relatively low, while in the poorly suspending enamels the excess of sodium oxide is high. Enamel 13, which showed the largest excess of free alkali, gave most difficulty because of settling. While it may be possible to establish limits for the sodium oxide-boric oxide ratio in which enamels may be expected to give good suspension, further data on a more extended range of compositions will be necessary if this is to be accomplished.

The excellent floating properties of those enamels with a large amount of borax in the mill liquor, and the common practice of adding borax to a ground coat for proper suspension, suggested similar treatment for these enamels. It was found that 0.75 to 1.0% of borax would give fairly satisfactory suspension to these enamels, but difficulty was encountered with crawling during their firing.

The conclusion, that the poor suspending properties of Enamels 13 to 15 are due to excessive alkalinity of the mill liquor, is in accord with the work of Mayer,[4] who found this same condition in the settling of fritted glazes of the sodium-borosilicate type. He also stated that those glaze-makers using a frit composed only of boric acid and flint, never have any difficulty with settling, because a great quantity of boric acid is set free on grinding thus neutralizing any alkaline properties.

Ashley[5], in referring to the regulating of glaze suspension, stated that if the amount of alkali present is sufficient to keep the colloidal material in suspension, there is danger that the crystal or glassy grains may fall to the bottom of the dipping tub and set so firmly as to cause the dipper much trouble. The condition desirable in a glaze is that all the colloidal matter should be in the form of a thin jelly, which will hold up the granular matter.

With these facts before us, it is undoubtedly a mistake to attempt to determine the enamel suspending properties of a clay by noting its floating qualities when shaken up in water. Tests of enamel floating clays must be made with the type of frit with which they are to be used if they are to be of any value. This was well shown in an attempt to float Enamels 13 to 15 with certain well-known plastic clays. They were entirely unsatisfactory for floating these glasses as the clays in the presence of the ex-

cessive alkali remained in suspension indefinitely, while the frit settled out even before the mills could be emptied.

Effect of Some Electrolytes on Enamel Suspensions

Mayer divides the vehicles used for overcoming the excessive settling of glazes into those that act physically and those that act chemically. In the first group are clay, gum arabic, dextrine, milk, and syrup. The limitations on the use of these for enamels are such that they cannot be considered for our purpose. In the second group are various acid substances such as boric, hydrochloric, and sulphuric acids, which reduce the alkalinity by neutralizing part of the alkali. A more effective group of chemicals are those which neutralize part of the alkali and at the same time produce a flocculent precipitate. The more common of these are the salts of magnesium, barium, and calcium. All of these form gelatinous silicates, and the barium and calcium salts also precipitate gelatinous borates, all of which tend to assist in the suspension of the frit.

The addition of 0.1% of barium chloride, based on the weight of the frit, has a very decided effect in setting up an enamel, and in reducing the free alkali and borax. The following analyses of the mill liquors of Enamels 12 and 15 show this reduction very definitely.

TABLE VI

EFFECT OF BARIUM CHLORIDE ON SOLUBLE SALTS

	Enamel 12		Enamel 15	
	No addition (g.)	With 0.1% barium chloride (g.)	No addition (g.)	With 0.1% barium chloride (g.)
Sodium oxide in 10 cc. mill liquor	0.0167	0.0102	0.0130	0.0084
Boric oxide in 10 cc. mill liquor	0.0160	0.0112	0.0053	0.0038
Borax in 10 cc. mill liquor	0.0436	0.0305	0.0144	0.0105
Excess sodium oxide in 10 cc. mill liquor	0.0096	0.0053	0.0107	0.0067
Ratio of sodium oxide to boric oxide	1.05	0.90	2.50	2.20

Magnesium sulphate acts similarly on the very soluble enamels. However, in enamels such as Enamel 13, the amount required is sufficient to give difficulty with a sulphate scum on the surface of the enamel. This of course is objectionable as it reduces the luster of the enamel.

Nitric acid and hydrochloric acid were found to be excellent coagulants for Enamels 13 to 15, about 0.03% being ample to properly suspend the enamels. No detrimental effects were observed in their use. Boric acid in additions of about 0.03% solved the suspension problem, although there was a tendency for borax crystals to form and cause pitting in the fired enamel. This borax formation was due to the combination of the boric acid and free alkali.

Effect of Aging of Enamels on Solubility and Flotation

The solubility of an enamel increases with the time of aging as has been observed by Cook[8]. This is also shown in the analyses of mill liquors from Enamel 1, 24 hours after milling and after 12 days of aging. This batch was milled considerably finer than that for which the solubilities were reported in Table I, so the solubility is considerably higher.

TABLE VII

EFFECT OF AGING ON SOLUBILITY OF ENAMEL 1

	24 hours aging (g.)	12 days aging (g.)
Sodium oxide in 10 cc. mill liquor	0.0340	0.0460
Boric oxide in 10 cc. of mill liquor	0.0305	0.0530
Borax in 10 cc. mill liquor	0.0830	0.1443
Excess sodium oxide in 10 cc. mill liquor	0.0205	0.0226
Sodium oxide-boric oxide ratio	1.12	0.87

It is quite apparent that the rate of solubility increases more rapidly for the boric oxide than for the sodium oxide. It will be noted that Enamel 1 has a relatively high boric oxide content.

With further solution of sodium oxide and boric oxide occurring on aging of enamels, it is to be expected that changes in the set up and workability will take place. Undoubtedly the relative rate of solution of the two oxides on aging will depend on their percentages in the base frit. Thus a high soda enamel such as No. 13 might be expected to increase the amount of free alkali very rapidly while the continued solution of the boric oxide would not be as great.

This may partially explain why some enamels apparently improve on aging, while others deteriorate in their floating properties.

Another factor which should be considered in the aging of enamel is the possible absorption by an enamel of carbon dioxide from the air. Any absorption of carbon dioxide would decrease the alkalinity of the enamel, and a new coagulant, sodium carbonate, would be introduced into the enamel slip. The passing of carbon dioxide gas through an enamel of the type shown in No. 15, thickened the slip and decreased the alkalinity as shown by hydrogen-ion determinations.

Summary

The solubility of enamel glasses is largely dependent on the composition, and in general the effects of the various ingredients are similar to those for other types of glasses.

The composition and quantity of salts dissolved from the enamel glass during milling of the enamel have a very definite bearing on the suspension, workability, and other properties of the enamel. Those enamels which are excessively alkaline, due to the solution of considerable free alkali from the glass, have very poor floating properties, while those with excess

borax in the mill liquor tend to give difficulty with pitting and crawling.

A very important factor in the flotation properties of enamels is the ratio of free alkali to boric oxide dissolved from the enamels and present in the mill liquor. Limits for the proportion in which these two materials might be present and not interfere with flotation must be determined in further studies on enamels prepared under commercial conditions.

The poor floating powers of certain enamels can be corrected by the addition of suitable electrolytes. The kind and quantity of salts dissolved from the frit will determine the selection of the proper electrolyte.

The opinion of some enamelers that the ability of a clay to remain suspended in water is a criterion of its suspending powers for enamels is not borne out by the conclusions of various investigators.

It is quite evident that any future studies on the flotation and working properties of enamels must give careful consideration to the constitution and quantity of the individual salts dissolved from the frit during milling. The possibility of the absorption of carbon dioxide from the atmosphere during aging of the enamel must also be considered, because of the action of carbon dioxide in neutralizing the free alkali in mill liquors with the formation of coagulating salts such as sodium carbonate. Before broad conclusions can be drawn on the effect of aging, studies must be made of a wide variety of enamel compositions and of clays, in order that the effect of the soluble salts may have their full significance.

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A DEFORMATION STUDY OF COBALT OXIDE–ALUMINA–SILICA MIXTURES[1]

By Thomas M. Felton

ABSTRACT

A deformation study of CoO–Al_2O_3–SiO_2 mixtures was made to determine the fluxing effect of cobalt in such silicate mixtures as glazes and enamels. The deformation eutectics for cobalt and alumina, cobalt and silica, and cobalt–alumina–silica were determined and isothermal diagrams drawn.

Introduction

Cobalt oxide, although highly refractory, has a marked tendency to spread in glazes giving ragged or poorly defined dividing lines. To find an explanation of this, a fusion study of the system cobalt oxide–alumina–silica has been made.

Cobalt oxide and alumina, according to Hedvall[2] form two compounds, one a blue compound formed at 1100°C, having a chemical formula $CoO \cdot Al_2O_3$, and the other a green compound formed above 1100°C and having the chemical formula $4CoO \cdot 3Al_2O_3$.

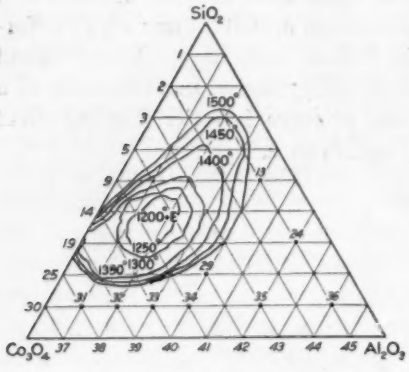

FIG. 1.—Deformation isotherms.

Cobalt oxide and silica when heated to bright redness (700 to 800°C?) form a violet orthosilicate, $2CoO \cdot SiO_2$.[3]

Method of Study

The fusions were made by making the various mixtures of cobalt oxide, alumina, and silica into cones and determining the temperature at which the cones began to deform and that at which fusion took place.

The components of the system were first ground separately to pass a standard 200-mesh screen. The desired mixtures were weighed from these finely-ground materials and then intimately mixed by grinding thoroughly in an agate mortar.

The cone fusions were made in a No. 3 gas-fired melter's furnace, manufactured by the American Gas Furnace Co. The cones were placed in a

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Terra Cotta Division.) A thesis presented for the degree of Master of Science in Ceramic Engineering, Ohio State University, 1927. Received Jan. 12, 1929.

[2] Hedvall, *Arkiv. Kem. Min. Geol.*, **5** [16], 1 (1914).

[3] Bourgeois, *Compt. rend.*, **108**, 1177 (1889).

crucible with a hole in the side permitting observation. The combustion gases and flames whirled around the crucible, the maximum temperature being 1504°C.

Thirty minutes were required to bring the furnace from room temperature to 800°C, after which the temperature was raised 40°C each 5 minutes.

The temperatures were measured by means of an optical pyrometer focused on the cone whose fusion temperature was being determined.

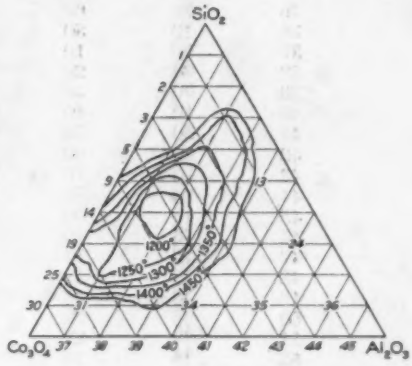

FIG. 2.—Fusion isotherms.

Results

The initial deformation temperature (I.D.T.) and fusion temperature (F.T.) of each of the mixtures made up are given in Table I.

TABLE I

No.	Composition Co_3O_4	Composition Al_2O_3	Composition SiO_2	I.D.T. (°C)	F.T. (°C)
1	10		90	Above 1504	Above 1504
2	20		80	Above 1504	Above 1504
3	30		70	Above 1504	Above 1504
4	10	20	70	1390	1450
5	40		60	Above 1504	Above 1504
6	30	10	60	1472	1504
7	20	20	60	1342	1395
8	10	30	60	1390	1440
9	50		50	1440	Above 1504
10	40	10	50	1250	1407
11	30	20	50	1265	1342
12	20	30	50	1355	1400
13	10	40	50	1472	Above 1504
14	60		40	1375	Above 1504
15	50	10	40	1217	1260
16	40	20	40	1191	1217
17	30	30	40	1310	1355
18	20	40	40	1472	1504
19	70		30	1342	1375
20	60	10	30	1250	1310
21	50	20	30	1204	1225
22	40	30	30	1250	1325
23	30	40	30	1407	1504
24	10	60	30	Above 1504	Above 1504
25	80		20	1375	Above 1504
26	70	10	20	1250	1325
27	60	20	20	1270	1342
28	50	30	20	1325	1407
29	40	40	20	Above 1504	Above 1504
30	90		10	" "	" "
31	80	10	10	" "	" "
32	70	20	10	" "	" "
33	60	30	10	1440	" "
34	50	40	10	Above 1504	" "

TABLE I (*Continued*)

No.	Composition Co_3O_4	Al_2O_3	SiO_2	I.D.T. (°C)	F.T. (°C)
35	30	60	10	" "	" "
36	10	80	10	" "	" "
37	90	10		" "	" "
38	80	20		" "	" "
39	70	30		" "	" "
40	60	40		" "	" "
41	50	50		" "	" "
42	40	60		" "	" "
43	30	70		" "	" "
44	20	80		" "	" "
45	10	90		" "	" "
46	46	10	44	1200	1260
47	42	14	44	1191	1250
48	38	18	44	1200	1260
49	40	18	42	1225	1240
50	38	20	42	1225	1240
51	36	22	42	1210	1280
52	46	14	40	1204	1250
53	44	16	40	1200	1225
54	42	18	40	1200	1225
55	38	22	40	1225	1260
56	44	18	38	1191	1225
57	42	20	38	1178	1200
58	40	22	38	1191	1240
59	38	24	38	1210	1270
60	55	10	35	1217	1250
61	50	15	35	1217	1240
62	46	18	36	1191	1225
63	44	20	36	1191	1217
64	42	22	36	1178	1217
65	40	24	36	1225	1270
66	40	26	34	1200	1270
67	55	15	30	1225	1250
68	66		34	1300	1342
69	68		32	1280	1325
70	72		28	1325	1350
71	74		26	1342	1375
72	76		24	1360	1375
73	96	4		Above 1504	Above 1504
74	94	6		" "	" "
75	92	8		" "	" "
76	88	12		" "	" "
77	86	14		" "	" "

The compositions of the mixtures in the table are expressed in gravimetric per cents.

The majority of the cones tested did not deform as do pyrometric cones, but due to surface tension melted down into hemispherical form. The temperature at which the molten mass assumed the above shape was taken as the fusion temperature of the cone, equivalent to that temperature at which the tip of the cone would normally bend to touch the cone plaque.[4]

In cones 10, 14, 20, 25, 71, and 72, a partial fusion took place, the fused portion passing down through the cone to the bottom ("coring") causing the cone to slump over. Cones 10, 20, 71, and 72, fused completely at

[4] Fieldner, Hall, and Field, "Fusibility of Coal Ash and the Determination of Softening Temperature," Bur. Mines, *Bull.*, No. 123.

the temperatures given in Table I, but cones 14 and 25 did not fuse completely.

Of the cones which did not come down, 30, 73, 74, 75, 76, and 77 showed some vitrification. Cone 75 appeared to have vitrified more than the other cones in the series 73 to 77, inclusive.

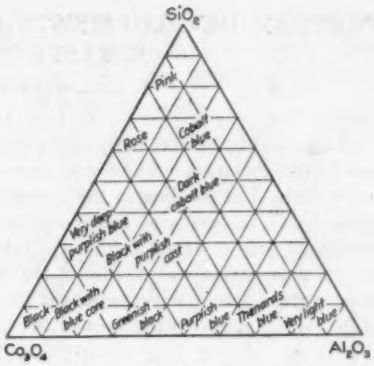

FIG. 3.—Color of sintered mass before grinding.

Conclusions

From the results it would seem that (1) the deformation eutectic temperature of the cobalt oxide–silica series is 1325°C, the composition of this deformation eutectic being 32% SiO_2 and 68% Co_3O_4.

(2) The composition of the alumina–cobalt oxide deformation eutectic is approximately 10% Al_2O_3 and 90% Co_3O_4.

(3) The deformation eutectic temperature of the cobalt oxide–alumina–silica system is 1200°C, and the composition 38% SiO_2, 20% Al_2O_3, and 42% Co_3O_4.

(4) Although alumina and cobalto-cobaltic oxide are highly refractory materials, and although all mixtures of these two materials are very refractory, the addition of silica in amounts up to approximately 70% will greatly reduce the melting temperature.

(5) Cobalt oxide in the presence of alumina and silica is very active flux. This may account for the fact that cobalt colors, when used in glaze decoration, have such a marked tendency to spread.

Acknowledgment.—The writer wishes to express his indebtedness to A. S. Watts and W. J. McCaughey for their helpful suggestions and assistance in the preparation of this work.

FURTHER DEVELOPMENTS ON TORSIONAL APPARATUS FOR MEASURING PLASTICITY[1]

By C. W. Parmelee and R. D. Rudd

ABSTRACT

A critical study of the apparatus has been carried on to reduce variations in results due to manipulation. Specimens were made by squeeze molding in saturated plaster molds instead of forming in the hands. The loading device was changed so that the stress could be increased continuously instead of intermittently as heretofore. The specimens were designed so that the ratio of the maximum stress in the outer fibers of the circular section was to that of the square section as 3.8 is to 1. Clays having the same water content were compared by studying the slopes of the stress-strain curves up to the proportional limit.

Purpose of Investigation

In spite of the great amount of research done on plasticity, a completely satisfactory measure of this property and therefore reliable data are not on record. In view of this fact, the investigation of the torsional method of measuring plasticity, primarily conceived by Talwalkar and Parmelee,[2] has been continued. After the accumulation of a considerable quantity of data, it was deemed necessary, in February, 1928, to refine and redesign the test. The present discussion is merely a progress report of the changes made in the apparatus and manipulation, which we submit in view of the contribution made by Irving and Dietrich.[3]

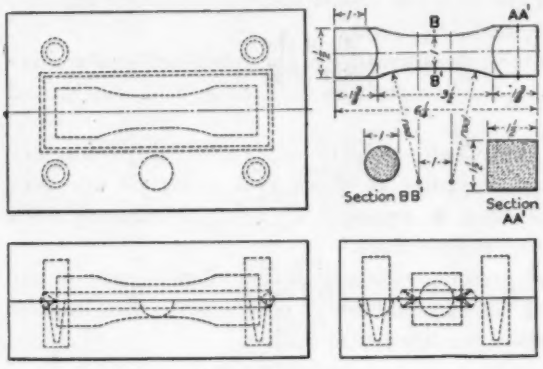

Fig. 1.

Review of Literature

The initial attempt to use a torsional method as a measurement of plasticity was made by Talwalkar and Parmelee, who used an apparatus consisting of two chucks in which

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Illinois, February, 1929. (White Wares Division.) The data presented were obtained in an investigation conducted by the Engineering Experiment Station, Univ. of Illinois, M. S. Ketchum, Director, under the supervision of C. W. Parmelee, head of the Department of Ceramic Engineering. This paper constitutes a partial summary of results to be presented complete in an Eng. Expt. Sta., *Bulletin*.

[2] Talwalkar and Parmelee, *Jour. Amer. Ceram. Soc.*, **10** [9], 670–85(1927).

[3] *Jour. Amer. Ceram. Soc.*, **12** [1], 14–29 (1929).

the ends of a cylindrical rod of plastic clay were placed. One chuck was stationary while the other was turned by a torsional moment. The amount of stress produced by this moment and the amount of strain produced in the specimen at the point of fracture were the basis of comparison of various clays having similar water content.

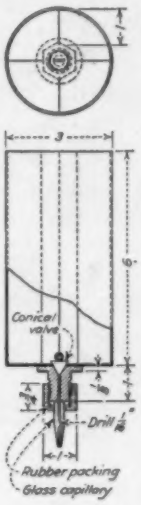

FIG. 2.

Experimental Work

Due to the discontinuities in the results the following points in manipulation and design were critically studied.

Preparation of Specimens Heretofore the specimens were cut from a roll of plastic clay in the form of a 1 x 1 x 6-inch piece; the center portion was rounded in the hands of the operator; the piece was placed in a saturated plaster mold in which the square ends were formed by punching the clay column into the mold; the specimen was then ready to be tested. This operation seemed quite simple, but serious practical difficulties were experienced in securing uniformity whether the specimens were made by one person or several. As a result squeeze molds of plaster were made in which a block of clay was placed and the specimen was forced into shape. This method is not perfect but it gives comparative results and lessens the variations due to personal manipulation.

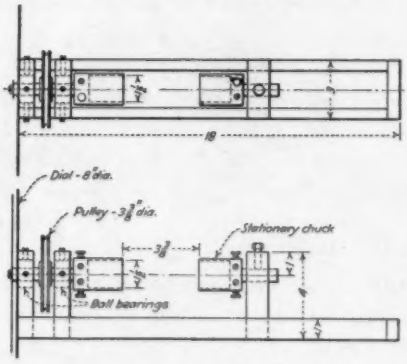

FIG. 3.

Shape of Specimens When the difficulty in preparing the specimens had been overcome, a more serious problem was confronted. It seemed that the specimens fractured at the point of change of section rather than in the portion having a circular cross-section. An analysis of the stress produced in the two sections showed that the ratio of the stress in the outer fibers of the square section to that of the circular was as 1 is to 1.13. The questionable results were caused by the abrupt change from circular to square cross-section in the specimen and by the slight difference in stress in the outer fibers of these sections. In view of these facts, the specimen was changed in design so the stress in the outer fibers of the square end was to the stress in the outer fibers of the center circular portion as the order of 1 to 3.8.

The new specimen will be noted in Fig. 1. This change along with the new method in preparation of the specimen gave more consistent data.

Loading Device

In all the previous tests the rate of the application and amount of the increments of the load were at the discretion of the operator. One can readily see that the personal factor in such operation is indeed enormous. Aside from the personal factor the method of application of load must be considered. The placing of the increments of load on the pan used in the early developments acted as a repeated stress. The amount and character of this load was indefinite and difficult to reproduce.

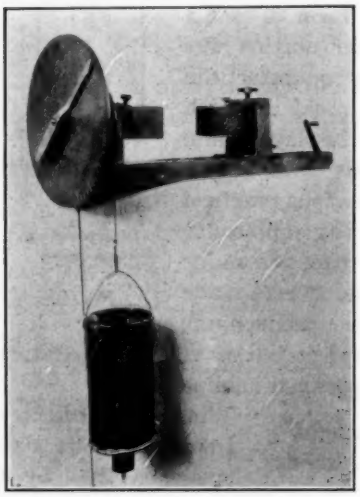

FIG. 4.

For these two reasons the method of adding weights to the suspended pan was given up in favor of a calibrated flowing water device, as shown in Fig. 2, which continuously applies the load. The loading device is simply a cylindrical copper can on the bottom of which has been fastened a capillary through which the water flows. Four fins have been placed in the can to reduce the whirling of the water in the form of a vortex. A check valve consisting of a brass cone is ground to fit a brass seat which has been fastened in the bottom. Below this valve is the glass capillary. This arrangement of the capillary has proved very desirable in that capillaries of various sizes and types could be used with a minimum amount of trouble in changing them. The important apparatus is shown in Figs. 3 and 4.

Analysis of Data

The point of fracture has proved itself to be quite indefinite depending upon the nature of the clay and the water content. It was also difficult for two observers to obtain the same point of fracture for the same test. In view of this fact, this point was abandoned in favor of the slope relations of the stress-strain curves up to the proportional limit. The slopes are determined as a mean from a set of about fifteen tests per sample of clay.

Figure 5 shows the relation between slopes of Tennessee No. 1 ball clay and H & G A1 English china clay. It will be noted that the slope decreases as an increasing amount of china clay is added to the ball clay when the water content is constant.

Figure 6 shows the effect of additions of nonplastic, such as flint, to a ball clay on the slope when the water content is varied.

The importance of the fracture point has made the investigators study its determination very closely. A method is being devised but has not

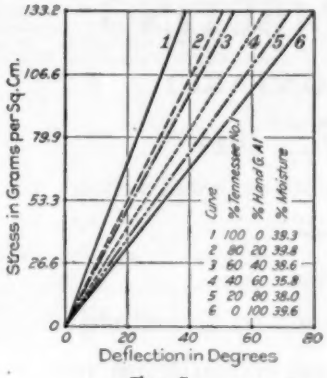

FIG. 5.

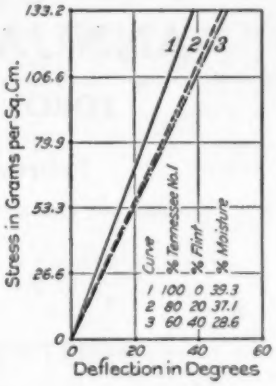

FIG. 6.

yet met with entire success. For this reason this method along with a large amount of data has been withheld for a later and complete publication if further investigations warrant such.

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Abrasives

Theory of grinding. M. J. Nerkritsch and Peter P. Budnikoff. *Zement*, **18** [7], 194–97; [8], 230–33 (1929); *Rock Prod.*, **32** [11], 85 (1929).—N. and B. of the Technological Institute, Charkow, Russia, review the literature relative to the theory of grinding, selecting the results on the nature of the materials and their grinding in respect to the efficiency of grinding machines, using at least 28 references, including S. Ure, F. A. Kirkpatrick, A. J. Dale, G. Martin, A. Bowers, J. Christelow, F. Turner, and W. A. Koehler. F.P.H.

Determining grinding wheel grades scientifically. Anon. *Abrasive Ind.*, **10** [5], 43–44 (1929).—A machine which grades grinding wheels with precision and accuracy has been perfected. It is the Grade-O-Meter manufactured by Abrasive Engineering Corp., Detroit. The selection of grinding wheels for each grinding operation is accomplished by comparison with the wheel in use. This instrument establishes definitely a standard grade of wheel hardness for each grinding operation. It is the bond which determines the hardness of the abrasive wheel. The function of the bond is to hold the abrasive grains in place while they are sharp, and to release them when the impacting force becomes great enough to overcome the resistance of the bond. If the bond is too strong the wheel ceases to grind and burnishing results with the generation of heat. If the bond is weak, the abrasive grains are released prematurely reducing the life of the wheel and the production efficiency of the grinding machine. In this new method of grading, the wheel is subjected to an impacting force similar to that which occurs in actual use. It distinctly defines the strength of the bond and is not injurious to the wheel. E.P.R.

Develop novel abrasive appliances. Anon. *Abrasive Ind.*, **10** [6], 44 (1929).—Abrasive files, half-round tapered shape with a steel rod running lengthwise through them, are used chiefly on jacket cores and the end of the steel rod protruding from the butt end is used for punching holes in jacket cores. Another abrasive tool of interest to the steel and other metal producing industries is the silicon carbide ladle nozzle reamer. E.P.R.

Centerless grinding out-of-balance work. J. E. Caster. *Abrasive Ind.*, **10** [5], 23–25 (1929).—One of the latest developments in the art of centerless grinding is the method for grinding out-of-balance work, a good example of which is the shock-absorber crank. To keep the work in a normal grinding position a spring finger was applied from the rear of the machine, exerting a slight pressure on the top of the portion being ground. Parts that are not in a balanced condition when they are revolved rapidly about the axis of the ground portion is the problem which is discussed. The important

factor with this class of work is to control the out-of-balance forces caused by the rapid rotation of the work so that they do not cause the ground section of the work to rotate intermittently about various axes. An equalizing shoe is in contact with the top of the work. The work blade has an angle top, and the shoe has an angular face, so a 3-point contact is established. If the pressure exerted on the overhead shoe is of sufficient magnitude, the out-of-balance forces will be overcome, and a state of dynamic equilibrium will be established. A production of four pieces per min. is obtained, removing 0.025 in. of stock from the heat-treated forging with a very good finish and with a 0.0005 in. limit. E.P.R.

Grinding two surfaces simultaneously. J. H. GROOM. *Abrasive Ind.*, **10** [6], 31–32 (1929); *Grits and Grinds.*—The grinding of shock absorber wing-shafts for small cars presents some interesting problems of the rather unusual shape of the piece and the great quantity to be manufactured. A plain cylindrical grinder with a swing of 14 in., and having a capacity of 18 in. between centers was selected for the grinding of the shaft portion and the wing diameter. The grinding wheel is 30 in. in diameter with 20-in. hole. Two wheels are used, one 2 in. wide and the other 1 in. wide. The 1-in. wheel is used to grind the two ends of the wing portion of the shaft, and the 2-in. wheel to grind the shaft itself. It is necessary to keep the diameter of the two wheels in exact relation to each other so that they will produce work having correct diameters. E.P.R.

Grinding process for naval gun production. ANON. *Abrasive Ind.*, **10** [6], 34 (1929).—The time-honored and expensive process of lapping the bores of large naval guns has been superseded by modern grinding equipment capable of handling work up to 16 inches in diameter and 61 ft. long. The accuracy obtained is phenomenal as these massive bores are finished with an error not to exceed 0.001 in. E.P.R.

Increase in use of industrial diamonds. ANON. *Abrasive Ind.*, **10** [6], 21–22 (1929).—In 1888, J. K. Smit (Holland), became impressed by the possibilities of using diamonds for mechanical purposes. The Amsterdam manufacturers of cut diamonds, were only too anxious to sell stones which were too hard or cross-grained for cutting purposes, but these stones are the best for industrial purposes. When the formation of diamonds is in regular layers they are easy to cut, but if they are all grown together in all directions, technically called "feing" or "naetig," it is impossible to cut them. In selecting diamonds for industrial purposes, it is necessary to understand the formation and grain, which knowledge, is the result of experience. In the ballas formation the crystallization starts from one central point, and this class of stones is therefore especially fit for drilling and other purposes. Stones of this type are not so liable to break, as those with the regular layer formation, but unfortunately ballas stones are very scarce. Johan Smit found out that the surest proof was to rub a Brazilian ballas, with a flat side against the carbon. A good Brazilian ballas is as hard as the finest quality carbon. By noting the amount of dust left on the flat side of the ballas, and by carefully listening to the scratching noise, it is possible to judge fairly accurately the hardness of the stone. E.P.R.

Filtered grinding lubricant. LLOYD E. PAYNE. *Abrasive Ind.*, **10** [6], 32 (1929).—An interesting and very efficient filter for readily removing foreign materials from the grinding lubricant when producing high finishes on cylindrical work has been used for some time. E.P.R.

Design segmental wheel. ANON. *Abrasive Ind.*, **10** [5], 45 (1929).—Blanchard Machine Co. (Cambridge, Mass.), has designed a 11-in. segmental wheel for No. 10 Blanchard surface grinders. It consists of a chuck body machined from a solid steel forging, 4 abrasive segments with rounded ends, 2 fixed partitions, or abutments secured in the chuck body, and 2 clamping units consisting of shoes fitting the ends of

the segments and expanded by a wedge and screw. Abrasives are segments 5 inches deep when new and of this length 4 inches can be used. E.P.R.

Wheel truing stones. ANON. *Abrasive Ind.*, **10** [5], 28 (1929).—A diamond is expensive and brittle and should be used with care. Feed the diamond to a grinding wheel slowly, as shock is disastrous. Never take a cut of more than 0.001 to 0.003 in. at one time. Have the stone reset as soon as a flat is worn on it. An overheated stone will not wear well. Do not use too small a stone. If the stone works loose in its setting it may break suddenly. Use it in such a way that the pressure is toward the crack, should the diamond have one. Cross-grained stones are preferred as they are always harder than the usual triangular formed stones. Knotty stones are termed "feining" by the European diamond cutters. A regular formed diamond is composed of flakes. Set the diamond so the flakes make contact with the wheel at right angles. The foregoing data were supplied by J. K. Smit & Zonen diamond dealers, Amsterdam, Holland. E.P.R.

Ball bearings in grinding wheels. ANON. *Abrasive Ind.*, **10** [5], 27–28 (1929).—An extreme degree of accuracy is necessary in bearings of grinding-machine spindles, for if the spindle has the least bit of "shake" in its bearings, the wheel will chatter. This article illustrates and describes briefly some typical installations. Grinding machines of all types, from floor stands to precision machines can be had with ball-bearing spindles. E.P.R.

Manufactured wheels replace sandstones in knife manufacture. DONALD A. HAMPSON. *Abrasive Ind.*, **10** [6], 17–20 (1929).—Alumina wheels show high efficiency when compared with sandstones as formerly used almost exclusively in the cutlery manufacturing trades. This article illustrates and describes interesting grinding operations performed at the plant of the Schrade Cutlery Co., a leading manufacturer of high-grade pocket knives. E.P.R.

Disk grinder has swing work table. ANON. *Abrasive Ind.*, **10** [5], 44–45 (1929).—The hand operated swinging work spindle was developed by the Gardner Machine Co. (Beloit, Wis.), for its No. 86 horizontal disk grinder of 30-inch capacity. E.P.R.

Floor grinder. ANON. *Abrasive Ind.*, **10** [5], 45 (1929).—The machine illustrated is a self-contained motor driven floor type grinder developed by Luke & Spencer, Ltd., Broadheath, near Manchester, England. The method of construction allows the use of a very heavy spindle. Correct grinding speeds can be obtained without the use of specially designed motors. E.P.R.

High production cylindrical grinding. R. E. W. HARRISON. *Abrasive Ind.*, **10** [6], 23–27 (1929).—The process of evolution through which the art of precision cylindrical grinding has passed during the last 7 or 8 yrs. is reviewed. Work which was regularly handled on 5-H.P. machines in 1920 and 1921, is today, being produced in a proportionately reduced time on 15-H.P. and occasionally on 20-H.P. machines. Considerable work is to be done in further elimination of idle or non-grinding time between the work cycles. E.P.R.

High speed grinder. ANON. *Abrasive Ind.*, **10** [6], 44 (1929).—The Rotor Air Tool Co. (Cleveland), has a new high production grinder, designed for use with 8 x 1-in. high-speed rubber, bakelite, and elastic-bonded wheels for grinding metals of high tensile strength, such as steel, electric, and acetylene welded sections, malleable iron, etc. In order to provide the required surface speed of 9000 ft. per min. for 8-in. wheels, the high production grinder operates under load at 4300 r.p.m. E.P.R.

Pneumatic grinder. ANON. *Abrasive Ind.*, **10** [6], 45 (1929).—A new portable pneumatic grinder (Ingersoll-Rand Co., New York, N. Y.) uses a multivane motor that combines the lugging power of a piston machine with the smoothness of a turbine. Speed governors are incorporated to give power where it is wanted and yet keep the

grinding wheel from operating at dangerous speeds. By means of the governor the unit can be adjusted to any desired speed up to 6300 r.p.m. Standard machines are set at 4200 r.p.m., which is the best speed for 6-in. vitrified and 8-in. wheels of elastic type. E.P.R.

Lapped bearing surfaces assure correct lubrication. J. A. CARSON. *Abrasive Ind.*, **10** [5], 31–32 (1929).—A surface free from protruding imperfections, with open pores that retain the oil film, and permit the surfaces to move, one against the other with a minimum degree of friction and wear without danger of the oil film becoming ruptured by these imperfections constitutes the perfect bearing. The only method of producing two uniform surfaces which are intended to and must operate smoothly and without friction, one with the other and together, is the lapping-in process. A lapping material consisting only of a single abrasive will not give satisfactory results, but will leave some of the abrasive embedded in the metal. This embedded abrasive will continue to cut after the machine is in operation. An abrasive mixture designed for finishing soft-metal surfaces, such as the main and connecting rod bearings of an automotive engine, will not lap cast-iron cylinders. On the other hand, a mixture that is satisfactory on cast iron is injurious when applied to soft metal bearings. E.P.R.

Timesaver lapping compound. ANON. *Abrasive Ind.*, **10** [6], 22 (1929).—The Abrasive Engineering Laboratories Inc. recently acquired from the Timesaver Products Co. the exclusive rights to manufacture and sell timesaver lapping compound. E.P.R.

Lapping plain bearings of bronze or babbitt. H. J. WILLS. *Abrasive Ind.*, **10** [6], 33 (1929).—Finishing of soft-metal bearings by lapping with abrasives to take the place of the more expensive and less accurate method of scraping by hand is receiving considerable attention among abrasive and production engineers. Twenty-two grades of finishing compounds have been formulated for lapping gears, bearings, and other mechanical moving parts. Finishing of plain bearings of bronze or babbitt by the hand-scraping method requires considerable time and skill and when finished the bearing and shaft seldom have more than 50% metal-to-metal contact. On account of the accurate proportioning of the abrasive grains to the carrier medium, lapped bearings invariably present from 75 to 90% metal-to-metal contact, which means less consequent taking up and longer life of the bearings. In order to expedite the lapping of solid bearings it is sometimes desirable to use a split cast iron or wood lap in place of the shaft. On certain precision machines requiring three-point bearings, a turned wood lap flattened on three sides, wetted with compound should be reciprocated straight into the bearings. This type of lap will give the three points desired and create a relief for the oil. The use of the compounds in question for lapping bearings eliminates the danger of the abrasive grains charging or impregnating the metal. This elimination is due to the characteristics of the abrasive and the carrier medium. Water is used for thinning the compound and kerosene for cleaning the parts after lapping. E.P.R.

Lapping. ANON. *Abrasive Ind.*, **10** [6], 35 (1929).—H. J. Wills (Carborundum Co.), specially stressed the development of abrasives and compounds suitable for the surface lapping of bronze and babbitt bearings in an address before the students of the General Motors Institute of Technology (Flint, Mich.). E.P.R.

Four-station polishing machine. ANON. *Abrasive Ind.*, **10** [6], 43–44 (1929).—The Excelsior Tool & Machine Co. (East St. Louis, Ill.), has developed an automatic 4-station polishing and buffing machine, of the continuous rotary-feed type, designed for the rough grinding, polishing, or buffing of flat and semiflat articles of manufacture. E.P.R.

Polishing brass nuts. ANDREW V. RE. *Abrasive Ind.*, **10** [5], 50 (1929).—In finishing acorn-shape brass nuts on a quantity basis they can first be polished on a grease

wheel set up with No. 120 emery after which they are put over an oil wheel. The wheel for the first operation is made of shirting buffs glued together and for the second operation a medium texture felt wheel is used. They next are color buffed and by keeping part of the wheel face free of rouge, this section can be used to remove the cloudy appearance left by the rouge. The nuts then are ready for the plating room. E.P.R.

Polishing composition in the electroplating industry. LESLIE WRIGHT. *Abrasive Ind.*, **10** [5], 52–56 (1929).—Abrasives are of two classes, natural and manufactured. The more important natural abrasives for electroplaters are rottenstone, tripoli, pumice, and emery. W. describes the chemical and physical characteristics of each of these natural abrasives in considerable detail. Lime compounds are used considerably for the finishing of nickel plate and to obtain a high luster on copper and brass. Rouge and crocus form the residue left behind in the dry distillation of ferrous sulphate to form nordhausen sulphuric acid. Rouge is the name given to the red variety which has not been as strongly heated as the bluish-purple crocus. The difference in color of these materials is due to differences in grain size. Their exact composition is not known, but they are hydrated oxides of iron. Precipitated hydroxides of iron do not have abrasive quality. Rouge is used for the previous metals and crocus on tin and cutlery. Chromium oxide has become of considerable value in the manufacture of compositions for the finishing of chromium-plated ware. Other manufactured abrasives are putty powder, manganese dioxide, carbide of silicon, and manufactured alumina. The extent to which an abrasive medium will wear or cut away the metal to be finished depends on hardness and structure of the abrasive, pressure, hardness of the metal, and the freedom with which the abraded particles and useless abrasive can fall away. In smoothing or polishing a metal, the abrasion at first is due to the cutting action of the most projecting points of the abrasive. The enormous heat developed by the friction must affect the luster. This heat is much greater than is generally realized. It is possible to melt britannia metal by pressure against a revolving buffing wheel. The most important greases used in making molded buffing compositions are stearic acid, mutton tallow, and paraffin wax. Most compositions contain the foregoing ingredients, but in addition other animal and vegetable and mineral waxes, such as ozokerite and carnauba, are used. Stearic acid is a pearly white crystalline fatty acid of the acetic acid series. Its formula is $C_{17}H_{35}COOH$ and it has a melting point of 69.3°C. It is produced by the hydrolysis of tristearin. Tallow is the solid fat of oxen and sheep and consists of tristearin, tripalmitin, and triolein. It has a melting point of approximately 45°C. Paraffin wax is produced as a white wax by the distillation of oil-bearing shales. It is obtainable in different grades, depending on its melting point, which may vary from 35 to 60°C. Ozokerite is a very hard variety with the highest melting point. They are saturated hydrocarbons with a straight-chain constitution. The making of a good grease bond presents three distinct problems. They are the control of the hardness and body of the resultant mixture, the control of the range of temperature between the melting and vaporization points, and the degree of saponification. The control of the body and hardness determines the amount of abrasive that the compound will hold. The control of the range of temperature between the melting and the vaporization points is most important because the abrasive sticks to the wheel only as long as the grease is there to bind it. An accompanying diagram gives a ready method of finding this relationship. E.P.R

Aluminum polishing suggestions. A. ROSSEAU. *Abrasive Ind.*, **10** [5], 56 (1929); *Grits and Grinds.*—Aluminum articles are usually cast in sand, die cast in molds, or formed from sheets in power presses. Practically all aluminum articles are polished. The metal is soft and ductile and is easily cut but in many instances sand or small pit holes must be removed. This is done by polishing with an abrasive. The size of abra-

sive and the type of polishing wheel to be used depends upon the method used in manufacturing the part to be polished and the size, shape, and condition of this part previous to polishing. The amount of material to be removed also affects the abrasive size. Each type of article presents a different problem and the ultimate finish desired must receive special consideration. R. discusses in detail the materials and processes used. E.P.R.

Polishing lathe. ANON. *Abrasive Ind.*, **10** [6], 43 (1929).—A two-spindle electrically driven polishing machine is similar in design to the single-spindle, electrically driven polishing and buffing lathe, but is designed with two independent spindles, having two motors mounted in the base and two separate starting switches and brakes. E.P.R.

Automatic polishing. H. C. BEACH. *Abrasive Ind.*, **10** [6], 46–48 (1929).—B. has made an exhaustive study of the application of modern electric furnace abrasives to polishing problems and in this article points out how automatic polishing in the manufacture of automobile bumpers solves an important production problem. E.P.R.

Early polishing skill. ANON. *Abrasive Ind.*, **10** [6], 54 (1929).—Polishing as a production operation in the U.S. is a comparatively old art and probably one of the first examples of early manufacture that entailed polishing was the production of revolvers. E.P.R.

Selection of buffing wheels. B. H. DIVINE. *Abrasive Ind.*, **10** [6], 48–54 (1929).—Attention is drawn to important factors to be considered in the selection of buffs. E.P.R.

Grinding industry. ANON. *Abrasive Ind.*, **10** [6], 35 (1929).—Manufactured abrasive wheels have replaced grindstones entirely in farm implement manufacture. E.P.R.

Cause of accidents with grindstones and grinding machinery. RUDOLF PLÜCKER. *Diamant*, **50** [36], 745–48 (1928).—The possibilities of accidents and the general prevention of accidents with grinding machinery are discussed. Proper balancing of wheels, mounting, etc., are some of the precautions that must be taken to prevent any mishaps. E.J.V.

Foundry grinding costs. F. A. LORENZ, JR. *Abrasive Ind.*, **10** [6], 28–29 (1929).—Grinding methods in all foundries constantly are undergoing changes as the builders of grinding equipment are redesigning their machines to provide more power, rigidity, bearing, and other characteristics which have helped to lower the cost of grinding. Many steel foundries have studied the subject of grinding from a really scientific and engineering viewpoint, realizing that rough casting grinding is just as much a machine operation as any other machine operation. One foundry made an extensive investigation of its equipment and, finding its 11 swing-frame grinders to be of obsolete type, replaced them with two modern high-speed grinding machines. The net result was a $66^2/_3\%$ reduction in grinding costs with 1 man producing the work formerly done by 5 or 6 operators. E.P.R.

Precision Grinding Wheel Inc., open branch. ANON. *Abrasive Ind.*, **10** [5], 25 (1929).—All plans are completed by the Precision Grinding Wheel, Inc., Philadelphia, for an office and warehouse, Detroit. E.P.R.

Issue commemorative brochure. ANON. *Abrasive Ind.*, **10** [5], 19 (1929).—To commemorate the completion of 40 years of successful operation, J. K. Smit & Zonen, diamond dealers (Holland), have issued a 48-page illustrated brochure. The forepart of the text is devoted to the activities of the founder, J. K. Smit, after which follows facts pertaining to the diamond trade. Some excellent data also are included on the use of diamonds for wheel truing and drilling. E.P.R.

PATENTS

Controlling device for machine tools. KARL JUNG. U. S. 1,717,385, June 18, 1929. A controlling device for machine tools, particularly grinding machines comprising, in combination with a sliding carriage, hydraulic means for moving the carriage to and fro, a separate hydraulic source of power independent of the means controlled by the carriage at the end of its travel and means energized by the source of power and reversing the travel of the carriage.

Grinding machine. GUSTAV DAVID SUNDSTRAND. U. S. 1,717,899, June 18, 1929. A grinding machine comprising, in combination a support, a work table, automatic means to move the work table horizontally, a work carrier vertically slidable on the work table, suspension means from the support to the carrier, pivoted on the support and tending to hang vertically therefrom, the horizontal motion of the table swinging the carrier through an arc about the pivot of the suspension means, and means between the support and the table to hold the table in any position against the tendency of gravity to move the carrier to its lower-most position on the arc.

Grinding head or attachment. FRANK R. MOORE. U. S. 1,717,995, June 18, 1929. A grinding attachment of the character stated, comprising a pair of spaced frame members, a driving shaft extending transversely of the upper part of the frame members, journaled therein and extending through one of the frame members, a driving roll carried by the driving shaft, a shaft extending transversely of the lower part of the frame members, an idle roll carried thereby, a guiding channel in the lower part of each of the frame members, a shaft supporting yoke slidably mounted in the guiding channels, a shaft carried by the guiding yoke, a second idle roll carried by the shaft, an abrasive belt extending around the driving roll and the pair of idle rolls, and means to lock the last-named shaft in any adjusted position.

Apparatus for grinding tools. GERARD A. DE VLIEG. U. S. 1,718,193, June 18, 1929. A blade-sharpening machine including a grinding wheel; a revolving blade holder serving to present the blade that is to be sharpened to the wheel; and mechanism for defining a line of grinding contact conforming in part, to an elongated blade crown and a portion receding from such crown in the plane of the blade at each end thereof, the plane of rotation of the grinding wheel where it is in grinding contact with the blade being substantially in a chord of the circle of rotation of the ground blade edge.

Rectifying element. MINER L. HARTMANN AND MORROW C. MILLER. U. S. 1,708,571, April 9, 1929. A rectifying element comprising a fragment of silicon carbide whose surface is free of those mineral impurities that are formed on the crystal in the manufacture thereof.

Detector. MINER L. HARTMANN AND MORROW C. MILLER. U. S. 1,708,572, April 9, 1929. A detector for high frequency electrical oscillations, comprising a cleaned fragment of silicon carbide free of surface impurities normal to silicon carbide and which form thereon in its manufacture and a hard flat metallic plate pressed in contact therewith.

Grinding end faces of lips of twist drills. SIDNEY C. PROBERT AND ROBERT E. SPURR. U. S. 1,714,136, May 21, 1929. A drill grinding machine having, in combination, a rotary grinding wheel, a slide movable transversely of the wheel, a rotary indexing chuck mounted on the slide and arranged to grip the periphery of the drill, a pivot for the slide about which the slide is arranged to swing in a plane transverse to the plane of the wheel, means for locating the chuck in either of two predetermined positions 180° apart for grinding opposite sides of the drill, and a support about which the slide may be rocked on an axis substantially parallel to the axis of the drill to vary the clearance.

Grinding machine. FRANK T. SEIBERT. U. S. 1,714,246, May 21, 1929. In a

machine for grinding and finishing long cylindrical work, such as shafting, means for simultaneously feeding longitudinally and rotating the work, a grinding unit adapted for operation upon the work, the grinding unit comprising a pivotally supported grinding wheel and backing up roll independently mounted to engage the work on opposite sides, means normally urging the grinding wheel away from the work, and adjustable means for connecting the backing up wheel for movement in a direction transversely of the work in unison with the grinding wheel.

Grinding machine. GERARD A. DE VLIEG. U. S. 1,714,499, May 28, 1929. A relief grinding machine having, in combination, a grinding wheel having an annular grinding face, the radial elements of the face being straight over a substantial portion of the width of the face and receding inwardly at their inner ends, means for supporting a cutter having a helical cutting edge and presenting the edge to the face between the axes of the wheel and the cutter, the grinding wheel being laterally inclined relative to the means, means for moving the 1st-mentioned means relatively to the grinding wheel so as to move the edge longitudinally across the face, and means for rotating the cutter in timed relation to the inclination of the edge, the points of contact at opposite sides of the face being in different elements so as to provide a gradually accelerated relief.

Fluid-pressure controlling and reversing mechanism for grinding machines, etc. ALFRED P. BURNS. U. S. 1,714,545, May 28, 1929. A table, fluid pressure means for reciprocating the table, a reversing valve for the pressure fluid operated by the table at each end of the latter's normal working path, means operable at will to prevent a reversal of the valve thereby to procure the withdrawal of the table by fluid pressure actuation from the working path, a normally open valve independent of the reversing valve, and means adapted to close the valve when the table reaches a predetermined point in its withdrawal movement, whereby to discontinue the flow of pressure fluid to bring the table to rest.

Sectional grinding wheel. JOSEPH L. BALLASH. U. S. 1,714,754, May 28, 1929. A sectional grinding wheel formed of a series of interfitting segmental blocks, the contiguous faces of each pair of contiguous blocks having an adapter bearing formed by a transversely concave groove in one block extending across the same intermediate the inner and outer edges and a correspondingly positioned rib on the other block adapted to fit and have a rocking bearing in the groove, there being a clearance between the adjacent faces of the blocks between the rib and groove and inner and outer edges of the faces.

Relieving mechanism for grinding machines. JOHN BATH AND ERNEST A. WALKER. U. S. 1,715,054, May 28, 1929. In a grinding machine, a wheel spindle, a work rotating member, means to rotate the spindle and member, means to regularly vary the relative positions of the spindle and member, and means including an auxiliary cam plate arranged to coact with the first means to change the locus of such variations.

Wheel-dressing mechanism. GERARD A. DE VLIEG. U. S. 1,715,122, May 28, 1929. The combination with a grinding wheel of a support, a hood for the grinding wheel mounted in telescoping relation with the support, means for adjusting the hood on the support relative to the grinding wheel, and a dressing mechanism carried by the hood in operative relation to the grinding wheel.

Buffing wheel. EDWARD S. HERBERG. U. S. 1,715,362, June 4, 1929. In a buffing wheel the combination with a pack of concentric circular disks of flexible absorbent fabric material, of concentric facing disks of smaller diameter on each side thereof formed of fibrous flexible material adapted to absorb a stiffening medium, a ring of fastening means through all of the disks drawing the disks snugly together along the line of the fastening means and extending around the axis of the wheel at a distance from the

center, and a hardening stiffening medium absorbed in the absorbent materials of the disks and forming a tough hardened circular core within and extending to the fastening means, the portion of the fabric and fibrous disks beyond the core being uniformly flexible.

Grinding machine. JAMES N. HEALD, ROGER N. HEALD, AND EDWARD M. TAYLOR. U. S. 1,715,550, June 4, 1929. In a grinding machine, the combination with a magazine for holding a stack of articles to be ground, and a carrier plate below the magazine to transfer the articles one by one to a position where they may be operated upon by a grinding wheel of means for lifting the magazine when the carrier plate is operated.

Abrading apparatus. RUDOLPH ANTHONY SKRIBA. U. S. 1,715,574, June 4, 1929. In an abrading apparatus, a dust control comprising means for directing tangentially an atomized spray on an abrading element at the point of abrading, and an electrical operating circuit for driving the abrading element, the circuit including a solenoid operated valve to control the spray.

Truing and dressing grinding wheels. FERDINAND J. HOHNHORST AND FERDINAND J. KROEGER. U. S. 1,715,835, June 4, 1929. In mechanism for truing and dressing grinding wheels, an axle in the clamp bearing and extending laterally from the shank, a shell about the axle ball bearings between the shell and the axle, an abrading wheel secured to the shell, a safety guard partly encompassing the abrading wheel, and bolts securing the safety guard to the shank, one of the bolts received through the clamp bearing and a part of the safety guard for simultaneously clamping the bearing and the safety guard.

Band grinding machines. J. HUSER. Brit. 308,206, May 15, 1929. In a grinding machine having an abrasive band passing round rollers, the work is fed by means of rolls which may be adjustably inclined to the band to vary the rate of feed and which are mounted in a frame pivoted to a lever which is itself pivoted to a shaft and is fitted with a counterweight. The feed rolls are connected by a belt, and one roll is driven from the shaft through belt gearing and bevel gearing. To adjust the inclination of the rolls, the frame is swung about the axis of the shaft and is locked by bolts engaging arcuate slots. The rolls may be pressed down to feed and to rotate the work by means of a pedal.

Grinding knives. C. C. DAWE, LTD., AND C. DAWE. Brit. 308,386, May 15, 1929. A machine for grinding guillotine knives consists of a support for the knife, which lies horizontally during grinding, adjustable by worm gearing to suit the angle of bevel of the knife, and a cup-shaped grinding wheel carried by a vertical shaft in a head. The head is traversed to and fro along the knife by a screw driven in opposite directions by belt gearing from pulleys on the end of a shaft carrying a long pulley, the belts being moved on pulleys on the screw by means of striking gear operated by stops which are engaged by the head. The shaft is driven from the pulley by a belt running over jockey-pulleys; the blade rests, with the beveled edge at the front of the machine, against a ridge on the support.

Grinding internally. R. JUNG. Brit. 308,777, May 23, 1929. In an internal grinding machine, the work mounted in a chuck upon a hollow spindle is ground nearly to size by a reciprocating rotary or non-rotary tool and is then finished by a grinding tool carried by a rod within the spindle and moved into the work by a lever, the tool being withdrawn from the work. The tool may be non-rotary or may rotate in either direction; it also may be fed into the work from the side opposite to that shown.

Centerless grinding machines. V. A. B. HUGHES. Brit. 308,874, May 23, 1929. In a centerless grinding machine, the work is controlled so that it is ground in relation to a predetermined final axis as distinguished from finding and establishing its own axis. The machine comprises grinding and regulating wheels with a work-receiving

throat between them, two centering spindles in alignment with the throat and engaging the work therein, and a vertically movable work-rest projecting between the wheels and supporting the work held by the spindles, at least one of the spindles being movable in a direction toward the grinding wheel within the limits imposed by a receding stop mechanism.

Centerless grinding machines. V. A. B. HUGHES. Brit. 308,875, May 23, 1929. In a machine for grinding cylindrical work-pieces the work is automatically moved axially across the face of a grinding wheel until its full length is in contact with the wheel, is allowed to remain axially stationary but rotating until the rough grinding is completed, and is finally moved axially again while a finishing cut is being taken by the wheel.

Gear grinding or milling machines. MOSS GEAR CO., LTD., AND E. GREGORY. Brit. 308,938, May 29, 1929. The grinding wheel or milling cutter of a gear grinding or milling machine is mounted on a spindle having oppositely tapering sections of different conicities, these sections coacting with bearing surfaces provided in separately-adjustable members. The member is of sleeve form and its upper end is screwed to receive an adjusting nut bearing on the framing. The lower end of the member is internally threaded to receive a block screwing over the adjusting member and bearing against the framing. The spindle is carried at its upper end in a ball bearing and is driven through spur gearing and bevel gearing.

Heating feed water. AUXILIARE DES CHEMINS DE FER ET DE L'INDUSTRIE. Brit. 308,964, May 29, 1929. The regulator valve of the exhaust steam supply to the heater chamber of the parent Specification is modified to be shut on stoppage of the steam pressure from the main engine exhaust or the feed pump. The main regulator valve normally held open by the spring is caused to shut if the pressure in the heater chamber rises by the action of the piston forced down by pressure communicated through the pipe. A separate piston, or pistons, is kept in raised position under the pressure of the main engine or feed-pump exhaust through connections. If one or both fail, as when the engine is shut off, the piston falls and a finger depresses the stem and main valve. The control may be effected mechanically where the feed-pump piston rod causes a crank to rotate, a roller running up the cam contour forces the cone against the spring and a bell crank lever causes a pull on a cable whereby a lever is held out of contact with the stem. On stoppage of the feed pump the cone is moved by the spring, the tension on the cable is relieved and the lever depresses the spindle and the attached regulator valve. Provision is made for by-passing the exhaust from other auxiliaries, which normally would go to the heated chamber, *i.e.*, the air compressor, to the atmosphere on stoppage of the feed pump.

Grinding or abrading wheels. NORTON CO. Brit. 308,991, May 29, 1929. A grinding wheel is made by first positioning a number of abrasive segments to form the grinding surface and then forming the internal supporting structure for the segments of a hardening fluid material such as concrete. The segments consist of abrasive grains bonded by vitrified ceramic material, and are provided with facing shoes of lead which are cast integrally thereon and are engaged by clamping blocks to hold the segments firmly onto the concrete body. Elastic strips of rubber or like material are interposed between the clamping members and the body. In making the wheel, a reinforcing network consisting of hoops, rods, and connecting wires is first loosely formed round a mandrel and bolts are threaded into the clamping blocks and the nuts placed in position. The clamping blocks are braced in position by temporary braces and the abrasive segments are slipped over the clamping blocks, wedged in position, and bound with wire. The concrete is then poured into the space between the mandrel and the segments and when this has set, the wedges are removed, the nuts tightened, and the

space between the segments is filled with lead which flows over the heads of the clamping blocks. Other hardening materials than concrete may be used and the method may also be applied to wheels which work on a plane end face or to other shapes of wheel.

Grinding and polishing cutlery. M. FAIREST AND H. BAINES. Brit. 309,270, May 29, 1929. In a grinding, polishing, or other machine in which the operation on a piece of work is performed in one reciprocation thereof, the work-holder being then moved from the tool to allow replacement, etc., of the work, *e.g.*, a piece of cutlery; the work-holder is supported by centers carried by brackets, the center being adjustable by a screw and the center being mounted on a block slidable in the bracket and pressed downward by a spring. The block has adjustably mounted thereon a roller which projects through the slide into a groove in a guide and as this slide is reciprocated on the guide to carry the work past a grinding-wheel, the roller moves first up an incline on a bar adjustably mounted in the groove to lift the work into contact with the wheel and then moves along the bar.

Artificial sharpening stones. C. BORODAY. Belg. 354,120, Oct. 31, 1928. Two plastic masses are prepared consisting, respectively, of (1) abrasive powder, talc, S, glycerol, dye, $MgCl_2$, and calcined MgO; and (2) corundum, S, glycerol, dye, $MgCl_2$, and calcined MgO. A layer of one of the compositions is placed in a mold, and a layer of the 2nd placed over the 1st so as to obtain a 2-face stone. (*C.A.*)

Art

Incrustation of ceramic ware. THEODORE LENCHNER. *Jour. Amer. Ceram. Soc.*, **12** [7], 498–501 (1929).—The history and evolution of the application of gold and other precious metals over acid-etched designs on glass, china, and enamelware is discussed. Details involving the preparation of the plate and transferring of the design to the article are briefly outlined and also the acid treatment of the article. The application of the metals, and finally a résumé of the incrustation as a decoration is given.

Linoleum block printed pottery. SADIE LOSHINSKY. *Jour. Amer. Ceram. Soc.*, **12** [7], 502–504 (1929).—A study of three methods for applying color to pottery with linoleum designs is presented. The procedure is practical for studio potters and small factories rather than for quantity production.

Style in ceramic ware. ANON. *Ceram. Ind.*, **12** [6], 654–56 (1929).—An outburst of color would describe in the fewest words, the present trend in ceramic ware of all kinds. The tendency, however, is toward less vivid colors and leans more toward the pastel shades. Some of the newest colors in ceramic ware are beige, slate blue, pinkish sun-brown, stone-grey mottles, and old ivory. One of the newest and most popular combinations in dinnerware, both decorated and undecorated, is deep ivory for borders, and a faint ivory for the center. In glassware, the newest tints have a tendency toward a decided faintness but reveal a deep color when light falls upon the ware. A smoky colored glass makes up one of the new attractive lines. Both French glassware and that of the Corning Glass Works show much of the black combined with crystal and have much of the ware decorated in numerous black lines. In some lines the usual tint colors are now often used for the foot or stem and crystal clear or with bubbles, cut or engraved, for the body. In some of the better glassware there seems to be a tendency away from color to rock crystal. Decorations on the better glass of current glassware are in many cases of classical subject and are also patterned after the old Stiegel and Caledonian. Much interest is being shown in modern art glass with decidedly imaginative shapes and design. "Bubble" glass is in demand, and is being shown in varied designs and degrees of clearness and opacity. Attractive toilet articles and bottles are made in this type of glass, and in some cases a small electric light arranged with pieces of colored glass is set underneath and gives a changing color to the article.

In glass, as also in pottery, two-toned ware has put in its appearance. This ware is of dark opaque green with a decoration in a lighter shade of green. F.P.H.

Durability of colors for painting on glass. FRIEDRICH GREINER. *Diamant*, **50** [28], 577–80, [29], 598–99 (1928).—A glass colorant is a soft glass which is more or less colored, generally being a lead silicate mechanically or chemically combined with some inorganic or metallic color. For greatest durability the firing temperature should be as high as is consistent with safety. Antique glass colors are discussed in brief. The nature of glass itself is discussed, and the effect of firing on of colors on its durability is mentioned. The resistance to weathering, to water, and to acids is a method used to determine the durability of glass and fired on colors. The effects of hydrofluoric acid, of the firing process, and room temperatures on glass colors are discussed. A good protective varnish to prevent the attack by moisture and CO_2 consists of a solution of beeswax and turpentine. E.J.V.

Colored glass for Washington cathedral. J. M. HAMMER. *Amer. Glass Rev.*, **48,** [36], 23–24 (1929); *Nat. Glass Budget*, **45**[5], 3 (1929).—That the Washington Cathedral, at Mt. St. Albans, Washington, D. C., may have stained glass windows, of exceptional character, a special glass factory has been built. Lawrence Saint obtained small but valuable samples of medieval glass. This was analyzed and as nearly as possible the batch compositions of hundreds of years ago are being reproduced today. It was found that the 13th Century glass contained sand, alumina, lime, magnesium, soda, potash, copper, manganese, barium, cobalt, lead, titanium, borax, sulphuric anhydride, phosphoric anhydride, and tin. Some of these probably were introduced unknowingly by the glassmakers of 700 yrs. ago and some were probably impurities. Working from chemical analyses of the 13th Century glass, Mr. Saint is trying to reproduce glass of same characteristics. He is confident that modern glass with a chemical composition similar to the best of the past also will endure for centuries. Approximately 25 lbs. of glass is made at one time from batches prepared carefully and scientifically. It is gathered on a blow pipe, blown and spun into small disks or "rundels." The completed rundels, after coming from the annealing leer, are from 11 to 14 in. in diameter and the variation in thickness is from $^3/_{16}$ to $^1/_8$ inch. The variations give the glass peculiar depths of tone and blend the rays of light in diverging and converging lines. The range of colors includes the basic colors of blue, green, flesh, pink-lavender, greenish-white, yellow, brown-pink, and red. Only a few of the possible shades of one color can be used in stained glass windows and much depends upon the selection, the thickness, and the shape of the piece of glass used in the intricate work of building up a window. E.P.R.

Modern china vs. old favorites. HESTER RAMSDELL. *Amer. Home* (June), p. 328 (1929).—Contemporary artists of recognized ability, working with craftsmen of the highest ceramic skill, have brought the American pottery industry to a very high plane. While most modern china is decorated under the glaze, overglaze decoration is used successfully in some of the most expensive and finely made china, but moderately priced china should be underglazed for permanence of design and color. The gold used today by the better potteries is 24-carat. While glaze is used to fill the pores of the biscuit ware, the cheaper grades of china seem to be slightly porous enough to absorb tea stains. T.W.G.

Electrical decorating muffle in the glass industry. KARL JIRSIK. *Diamant*, **50** [25], 520–21, [26], 541–42 (1928).—A description is given of an electric muffle being used at a plant in Czechoslovakia for firing on decorations, colors, lusters, and transparent designs. Details are given regarding the size, power requirements, temperatures obtained, modifications in design, etc., of the muffle. E.J.V.

Electrically heated coating tanks. ANON. *Nat. Glass Budget*, **45** [3], 5 (1929).—

H. O. Swoboda, Inc., consulting electric and mechanical engineers of Pittsburgh, Pa. has issued *Bull.*, No. 160, describing its "Falcon" electrically heated large asphaltum coating tanks. The fundamental advantages of the tubular electric heaters are outlined. It can be fitted into any type of tank, as long as sufficient space is available. E.P.R.

Electric firing in Italy. ANON. *Pottery Gaz.*, **54** [624], 974 (1929); translated from *Le Industrie dei Silicati.*—Various majolica factories, in their studios and tests, use small electrical furnaces of 2 or 3 cu. decimeters, which enable them to get up to 1000° in a few hours. These furnaces are mostly American and are very expensive. One of the furnaces which has been installed at the R. Scuola di Ceramica, at Faenza, is described in detail. A total consumption of about 400 kw. in 12 hrs. with a resultant temperature of about 1000°C is required by this furnace. E.J.V.

Multicolored face brick. ANON. *Brick Clay Rec.*, **74** [12], 808 (1929).—All of the colors borne by the multicolored rays of the sun in the clays of the earth, are cleverly depicted in the "Sun Burst Blend" panel set up by Vandeveer, Browne & Stoy, building supply dealers in Houston, Tex. The panel represents the sun rising early in the morning, including all the brick of the blend and some blue brick. The use of the different colored mortars is also depicted in the panel. E.J.V.

The Portland Vase. ANON. *Glass Ind.*, **10** [6], 145–47 (1929); see also *Ceram. Abs.*, **8** [7], 478 (1929). E.J.V.

English stoneware. FRANK DAVIS. *Illus. London News*, **174**, 816 (1929).—An account is given, with 4 photos, of the salt-glazed stoneware mugs and figures which John Dwight produced at Fulham from 1671 to 1703. Some of the figures are so competent that it is thought that he employed Grinling Gibbons to make them. H.H.S.

14th Century stained glass. JAMES J. RORIMER. *Bull. Met. Mus. Art*, **24** [5], 130–31 (1929).—Two panels of 14th Century stained glass, probably from the vicinity of Cologne, are on exhibition in the Room of Recent Accessions. On one of the panels Christ is shown holding a golden key in one hand; on the other Saint Peter, depicted as the founder of the Roman Church and the first universal bishop, is kneeling and looking toward Christ in adoration. These panels are placed in architectural niches. The colors are rich and vivid against their background and the features of both Christ and Saint Peter are well drawn and full of expression. Rhenish glass of the 14th Century has more resemblance to 12th and 13th examples than does a French glass of this period. The colors of German glass are richer and perhaps more effective for this reason. There is a similar group of glass in the Kunstgeverbemuseum in Cologne. A.A.A.

Stained glass in Munich. HANS HUBER. *Diamant*, **50** [24], 497–99; [25], 517–19 (1928).—A brief description is given of some of the examples of stained glass produced by some of the old masters which may be seen on exhibit in the Bavarian National Museum, some of which date back to the 10th or 11th Century. E.J.V.

Glass staining in Switzerland. N-R. *Diamant*, **50** [28], 581–82 (1928).—A short historical sketch, tracing the development of the stained glass art in Switzerland from about the 9th Century is given. E.J.V.

A krater by Polion. GISELA M. A. RICHTER. *Bull. Met. Mus. Art*, **24** [4], 107–10 (1929).—A beautifully proportioned Athenian red-figured krater has recently been acquired by the Museum. It is not in very good condition but it is highly prized for it has the genuine signature of Polion, whose name is new among vase painters. The body of the vase is decorated with a frieze of Olympian deities and the hero, Herakles, all in statuesque poses; the neck has 2 panels in which are represented athletes in various attitudes. These pictures are framed by decorative bands of palmettos, lotus flowers, and tongues, and the volute handles are enriched with ivy patterns. The style of the paintings points to a date about 420 B.C., typically Greek. On the strength

of this krater other vases have been attributed to Polion and he takes his place as a distinguished vase painter of the latter part of the 5th Century. A.A.A.

Prehistoric Persian pottery. ERNST HERZFELD. *Illus. London News*, **174**, 872–73, 942–45 (1929).—Hitherto puzzling to archaeologists is the fact that in Sumer and Elam, not separated by any natural frontier, two civilizations differing in many respects, and especially in their pottery, existed side by side. H. concludes from recent excavations in Persia that the culture of Elam originated on the Iranian plateau and was brought thence. Photographs of Persian pottery are included. H.H.S.

Stained glass works. LISSI PAULFRANZ. *Diamant*, **50** [36], 742–44 (1928).—Some of the artistic products of Carl Bringmann, working in the studios of Bringmann & Schmidt, in Coburg, are briefly described. E.J.V.

Ostwald color theory. ALBERT P. SACHS. *Instruments*, **2**, 53–55, 85–89 (1929).—Description of Ostwald's color theory and of photometric apparatus. (*C.A.*)

PATENTS

Design for tumbler. CHARLES EVANS. U. S. 78,566, May 21, 1929 (reissue).

Design for saucer. CHARLES WEISS. U. S. 78,597, May 21, 1929 (reissue).

Design for plate. HAROLD TAYLOR ROBINSON. U. S. 78,697, June 4, 1929 (reissue).

Design for mirror. HOWARD P. KING. U. S. 78,631, May 28, 1929 (reissue).

Design for globe for illuminating fixtures. NICHOLAS KOPP. U. S. 78,632, May 28, 1929 (reissue).

Designs for bottles. ARCH B. TAYLOR. U. S. 78,667, May 28, 1929; ISAAC MILLER. U. S. 78,712, June 11, 1929 (reissues).

Design for a bottle. JOHN L. DUNNOCK. U. S. 78,735, June 18, 1929 (reissue).

Design for a dish. WILLIAM P. GRAHAM. U. S. 78,746, June 18, 1929 (reissue).

Design for a goblet. NICHOLAS KOPP. U. S. 78,765, June 18, 1929 (reissue).

Design for a sherbert glass. NICHOLAS KOPP. U. S. 78,766, June 18, 1929 (reissue).

Bubble or blister glass. REUBEN HALEY. U. S. 1,715,130, May 28, 1929. Making blown glassware, by gathering a core of molten glass on a blowpipe and depositing upon the core, while still molten, finely divided bubble-forming material, incasing the core and bubble-forming material with molten glass, and blowing the combined gathers to form the article.

Decorating ceramic, glass, etc., articles. DEUTSCHE GOLD-UND SILBER-SCHEIDEAN-STALT VORM ROESSLER. Brit. 308,226, May 15, 1929. Ceramic, glass, etc., articles are decorated by first applying coatings of coloring solutions and then applying covering layers of substances which on firing the articles, remain liquid or become liquid, have a greater surface tension than the coloring layer underneath, and contract to a netlike structure of which the lines or veins displace the adjacent coloring layer. The coloring solutions may be of the luster type consisting of metals, such as gold, silver, etc., or metal compounds, which are dissolved, colloidally, if necessary, with the addition of resins, etc., in oils such as oil of turpentine or oil of lavender. The covering layer may consist of glycerine, ethylene-glycol, chloralhydrate, etc., in aqueous solution, aqueous alcoholic solution, etc. Gum arabic, tragacanth, gelatine, etc., may be added to the solution, and also, if desired, cane sugar. The covering layer may comprise: gum arabic, 40 g.; glycerine, 40 g.; sugar, 100 g.; alcohol, 300 g.; water, 520 g., and such solution may be applied by brushing, dipping, or spraying to the dry or soft underlayer. The coated article is allowed to stand for some time before firing, or if desired the article may be preheated. The covering layers may be provided with colors which are different from the color of the luster and in such cases the ground layer may comprise colorless resin-oil mixtures.

Ceramics. "SFINX" SPOJENÉ SMALTOVNY A TOVÀRNY NA KOVOVÉ ZBOŽI, AKCIOVÀ SPOLECNOST. Ger. 472,583, Oct. 2, 1926. Decorative effects are produced on ceramic

and metal-coated ware by applying glazing material containing water or salt solution in the form of drops, in the rough glazing process, and then firing in the usual way. (*C.A.*)

Cement, Lime, and Plaster

Determination of silica in Portland cement pulverized raw material by aid of ultra-filtration. H. MINDERMANN. *Zement*, **18** [5], 124–28 (1929); *Rock Prod.*, **32** [10], 104 (1929).—According to M., synthetic cements are coming increasingly into use, these being cements in which not only the proportion of lime reaches a certain figure, but also the other important hydraulic factors, SiO_2, Al_2O_3, and Fe_2O_3. Such cements contain very definite figures of relation (hydraulic relation = $CaO:SiO_2 + R_2O_3$; silicate relation = $SiO_2:R_2O_3$; iron relation = $Al_2O_3:Fe_2O_3$), made necessary to obtain earlier or higher strength cements. The silicate and iron relations become as important as the hydraulic relation and make necessary the use of further raw components such as bauxite and iron ore residues, depending on the chemical composition of the raw limestone and marl or clay. The exact knowledge of the chemical composition and calculation of an accurate synthesis is essential in weighing up the raw components. All hydraulic factors are known to secure a high quality product. The determination of the quality of lime can be done in a relatively simple manner, accurately, and in very short time in various known ways. But the determination of the other factors, first of all that of silicic acid (SiO_2) requires considerable time, according to present methods. Recently, however, there appeared two articles by Hart on determining silicic acid by aid of membrane filters (*Ceram. Abs.*, **6** [8], 324 (1927)), and aid of ultra-filtration in silicates to be converted or decomposed (*Zement*, No. 32 (1927)), which methods offer a very desirable change in the analytical operating method employed thus far. But the second method of Hart, for investigating the raw flour for Portland cement, is of primary interest here because in most cases this mix consists predominately of silicates to be converted. F.P.H.

Tests of Keen's cement. ANON. Bur. Stand., *Tech. News Bull.*, No. 145, p. 40 (1929).—The present tentative specifications for Keene's cement (Proc. A.S.T.M.) require that the cement when mixed to a standard testing consistency as determined by the Southard viscosimeter shall set in not less than 2 or more than 4 hrs. and shall have a minimum tensile strength of 450 lbs./sq. in. No appreciable difference was found between the 7, 14, and 28 day-storage tests. According to these data and from tests made by others it appears desirable to change the requirements for the time of set in the specifications to not less than 1 hr. nor more than 4, retain the tensile strength requirements and substitute the modified Vicat apparatus for the Southard viscosimeter as a method for determining the standard testing consistency. R.A.H.

Relative merits of the dry and wet systems of Portland cement manufacture. H. H. BLAISE. *Rock Prod.*, **32** [11], 57–60(1929). F.P.H.

Gypsum and anhydrite as retarders of cement setting. C. R. PLATZMANN. *Pit and Quarry*, **18** [1], 63–64 (1929).—In order to understand the activity of gypsum or anhydrite as a retarder of the setting of cement, it is important to know its solubility in water. The presence of increasing amounts of calcium chloride and simultaneously rising temperatures decrease the solubility of gypsum in water. The Hart theory that anhydrite is a less active setting retarder than gypsum has been attacked by Meade (*Ceram. Abs.*, **8** [3], 171 (1929)) and Berger (*Ceram. Abs.*, **8** [3], 171 (1929)). Meade connects the action of gypsum or anhydrite with the composition of the cement and establishes an index or coefficient of activity which is equal to the percentage of alumina divided by the percentage of silica. Cements in which the index is below 2.5 are rapid setting, while, when the index is above this value slow setting cements are formed.

If the hydraulic modulus is greater than 2.0, then rapid setting need not be feared even when the aforementioned coefficient is less than 2.5. This conception is substantiated to a certain degree by the facts that each cement reacts differently toward gypsum and that each cement demands a specific addition of setting regulator. It is further stated that the crude gypsum which is added to the cement during its manufacture enters into the reaction only in the water-free state, for the reason that water is split off due to the temperature of the clinker as well as during the grinding of the cement. Naturally occurring anhydrite differs from that obtained from crude gypsum in that it has a greater affinity for water. While the former combines with the water only when it is finely ground, the latter easily combines with water. Practice has shown that the use of crude gypsum which contains 40% of anhydrite, affects the setting, retarding it to the same degree as when crude gypsum is ground alone with the cement. R.G.E.

Diatomaceous silica studies as admixture in concrete. ANON. *Pit and Quarry*, **18** [1], 90 (1929).—A study of the representative diatomaceous silicas produced in the U.S. for use as admixtures in concrete is now being made at the Bureau of Standards (Washington) for the purpose of developing federal specifications for this material. R. G. E.

Light weight aggregate for concrete. ANON. *Pit and Quarry*, **18** [1], 88 (1929).—Low-grade clays, shales, and shale rocks when heated to about 2000°F for a short period expand from $2^1/_2$ to 3 times their original volume. Materials sintered in this manner when subsequently crushed and used as aggregates, yield concrete of the same or somewhat higher compressive strength and of only $^2/_3$ the weight of concrete made with ordinary rock and sand aggregate. R.G.E.

Setting of plaster of Paris. ANON. *Pit and Quarry*, **18** [1], 88 (1929).—A large batch of calcined gypsum was mixed with sufficient water to bring it to standard consistency and 3 by 6-in. cylinders were cast 2 min. after mixing, and at one-minute intervals thereafter until the paste was too stiff to be forced into the mold.

Time after adding water (minutes)	Compressive strength (lb./sq. in.)
2	1070
3	1060
4	1100
5	1070
6	910
7	710

The material for the specimens at 6 and 7 min. had to be pressed into the mold. Similar results were obtained using retarded mixes with larger time intervals between the casting of the specimens, and using mixes containing various proportions of wood chips. R.G.E.

Testing plaster of Paris for quality. ANON. *Pit and Quarry*, **18** [1], 89 (1929).—A simple test for the convenient determination of the quality of plaster is given. R.G.E.

Manufacture of plaster of Paris. JOSEPH ROSSMAN. *Rock Prod.*, **32** [10], 66–72 (1929).—A review is made of the U. S. patents relative to the processes and apparatus for the production of plaster of Paris. F.P.H.

Relation between composition and strength of cement mortar on combined hardening. III. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **32** [1], 29B (1929).—N. studied the strengths of mortars of two types (low silica and high silica) of cements on long combined hardening tests, and compared them with those on long water-hardening or air-curing. The results are briefly summarized as follows: (1) On long combined hardening (1 day in wet air, 6 days in water, and then in air curing to 26 weeks (182 days) from molding), the strength of low silica type cements stopped increasing after

4 or 8 weeks hardening, as was the case on long water hardening. Thus the difference of strengths at the same ages in these two hardening tests is nearly constant at any curing age after 8 weeks. But in the case of the high silica type cements, the difference of strengths between these long combined and water hardening tests decreased gradually owing to the increase on water hardening. (2) On long air hardening (aged entirely in air), the strengths are very low, compared with those on water hardening or combined curing. The strength of low silica cements on long air hardening stopped increasing after 4 or 8 weeks, but in the case of high silica cements, the strength increases slowly on long aging. **IV.** *Ibid.*, **32** [4], 98B–99B (1929).—Studies on the combined hardening of blast-furnace slag cements and "soliditit" cements are reported. From the results obtained it is clear that the increase of strength on combined hardening to common curing is smaller in the blast-furnace slag cements than in the "soliditit" cements. This fact was again ascertained by long combined hardening tests (1 day in wet air, 6 days in water and then air cured to 8, 13, or 26 weeks from molding). The effects of admixture on the strength of mortars on combined hardening were studied. Acid admixtures, as pozzuolanas, Keisanhakudo (silica earth) kieselguhr, etc., increased the strength of mortars of cements of low silica type both on water and combined hardening, but they had very little effect on cements of the high silica type. **V.** *Ibid.*, **32** [4], 106B–108B (1929).—There are reported the results of strength tests of 1:3 mortars on a special combined hardening or repeated curing in water and air (1 day in moist atmosphere, 6 days in water, 21 days in air and again in water curing to 56, 91, and 182 days, or 8, 13, and 26 weeks from molding) and the relations between the compositions of cements of low- or high-silica type and the results of strength tests on long ages of several methods of curing as follows are discussed: (1) W; water hardening (1 day in moist atmosphere and then in water curing to 1, 2, 4, 8, 13, or 26 weeks from the molding); (2) OC: ordinary combined hardening (1 day in moist atmosphere, 6 days in water, and then in air curing to 2, 4, 8, 13, or 26 weeks from molding); (3) SC: special combined hardening (1 day in moist atmosphere, 27 days in water, and then in air curing to 8, 13, or 26 weeks from molding); (4) A: air hardening (1 day in moist atmosphere and then in air hardening without curing in water to 1, 2, 4, 8, 13, or 26 weeks from molding); and (5) RC: repeated combined hardening (1 day in moist atmosphere, 6 days in water, 21 days in air and again in water curing to 8, 13, or 26 weeks from molding). From the results of these five methods of curing it is seen that the increase of strength by three methods of combined hardening (OC, SC, and RC) are remarkable in the case of cement mortars of low-silica type but there are nearly no increases or decreases in the case of cement mortars of high-silica type. Further, a remarkable difference was observed between these cements of low-silica and high-silica types in the testing of the strengths of 1:4 and 1:5 mortars in comparison with 1:3 mortars. From the results obtained, the important difference between the chemical compositions of these cements of low-silica and high-silica types and the strengths of mortars on combined hardening was clearly determined. For Part I see *Ceram. Abs.*, **8** [3], 174 (1929); Part II, *Ibid.*, **8** [1], 16 (1929). E.J.V.

Bending strength of cement mortars. I. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **32** [5], 131B–33B (1929).—The calculation formulas of modulus of rupture and bending strength are compared as follows: Modulus of rupture: $R = \frac{M}{Z} = \frac{6\,LW}{bd^2} = \frac{6 \times 3 \times 50 \times w}{2.22 \times 2.25^2} = 80\,w$ kg./cm.^{2}, where b is breadth of test piece (2.22 cm.), d is depth (2.25 cm.), L is length of arm (3.0 cm.) and w is actual weight applied equal to $^1/_{50}$ of W kg. Bending strength: $B = \frac{M'}{Z'} = \frac{3\,L'W'}{2\,b'd'^2} = \frac{3 \times 7.4 \times W'}{2 \times 2.25 \times 2.22^2} = W'$

kg./cm.², where b' ($= d$) is breadth of test piece (2.25 cm.), d' ($= b$) is depth (2.22 cm.), L' is distance between two supports (7.4 cm.) and W' is actual weight applied. Using the results of compressive, tensile, and bending strengths, calculating the ratios of these 3 strengths at the same curing ages of 1, 4, 8, 13, and 26 weeks, respectively, N. discussed the properties of four sorts of cement samples mentioned above. E.J.V.

Studies on mixed Portland cements. I. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **32** [4], 101B–103B (1929).—The mixed Portland cement industry in Japan is on a small scale. There are two sorts of mixed Portland cements, blast-furnace slag and "soliditit" cement. The blast-furnace slag cement has recently made a remarkable progress in the strength of 1:3 cement, standard sand mortars. The "soliditit" cement shows no progress and is far inferior. The principle of the manufacturing process of "soliditit" (Jap. Pat. 42,160) was studied and the process modified by adding more siliceous admixture. This new mixed Portland cement is named "neo-soliditit" (Jap. Pat. 80,692). The "neo-soliditit" is a remarkable early high-strength cement, comparable to superior foreign early high-strength Portland cements. The strength of the "neo-soliditit" mortars has made a remarkable increase on a long aging and has reached to about 800 to 900 kg./cm.² of compressive strength and 50 to 60 kg./cm.² of tensile strength at the curing age of 13 to 26 weeks. E.J.V.

Composition of insoluble residue of various cements. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **32** [5], 133B–34B (1929).—In previous studies on lime-silica molecular ratios, and calcium silicate ratios of Portland cements, and relations of composition and strength of cement mortars on combined hardening, it was necessary to obtain the accurate amount of silica combining with lime. The insoluble residue is a mixture of alkali alumino-silicate (feldspathic material), crystalline silica, etc., insoluble in hydrochloric. Tabulated results show the principal compositions of ignited insoluble residue to be silica (average 80%), alumina and alkali, showing the mixture of alkali alumino-silicate and crystalline silica. N. adopted the factor 0.80 to insoluble residue to obtain the accurate amount of silica combining with lime as ($SiO_2 - 0.80 \times$ insol. res.). E.J.V.

Rationalization of shaft lime kiln design. II. VICTOR J. AZBE. *Rock Prod.*, **32** [11], 51–56 (1929).—The performance of 17 different kilns is discussed. For Part I see *Ceram. Abs.*, **8** [7], 482 (1929). F.P.H.

Fuel economy in the rotary kiln burning Portland cement clinker. ROBERT D. PIKE. *Rock Prod.*, **32** [11], 64–66 (1929).—For previous articles see *Ceram. Abs.*, **8** [4], 250 (1929); *Ibid.*, **8** [7], 482 (1929). F.P.H.

Waste-heat utilization in cement plants. ANON. *Fuels and Fur.*, **7** [1], 121–22 (1929).—In an installation to recover the heat from any type of commercial furnace the first consideration is continuity of service and flexibility and draft loss. Draft loss is increased by air infiltration, improperly designed flues, and too many turns in the system. Ordinarily the gas temperature must exceed 1000°F in order to justify waste-heat boilers. The life of induced draft fans cannot be predicted, but it will vary from 3 weeks to 3 yrs. Some of the users of these fans have resorted to the plating of the blades with stellite. This practice has proved economical even though the cost of plating is quite high. A.E.R.W.

Dust problems in cement plants. ANON. *Cement, Mill & Quarry*, **34** [6], 40–42 (1929). E.P.R.

Metropolitan plant completed. ANON. *Pit and Quarry*, **18** [1], 76–78 (1929).—The first of four metropolitan plants of the U. S. Gypsum Co. has been completed at Boston. Other sites for which plants are planned are Detroit, Chicago, and Philadelphia. The new plant consists of three main units; (1) the calcining mill, (2) the warehouse, and

(3) the board and block plant. The plant manufactures over forty products including both building materials and products for industrial use. R.G.E.

Belgium cement industry. C. R. PLATZMANN. *Rock Prod.*, **32** [11], 63 (1929).—The beginnings of the Belgium cement industry date back to the beginning of the 19th Century, when Roman cement was clinkered from lime-bearing clays (septarian clay) in kilns similar to those that served also for the production of lime. Natural cement was produced in similar kilns, clay-bearing limestone serving as the raw material. At the beginning of the 20th Century a great advance began in the Belgium cement industry, but especially after the rotary kiln came into more general application. Today there are about 29 Portland cement works which clinker with rotary kilns. A table gives the geographical distribution of the plants, the names of the concerns, and the raw materials being used. F.P.H.

Gypsum, its manufacture and uses. MARTELL. *Baumarkt*, **39**, 1325–26; **43**, 1452–53 (1928); *Rock Prod.*, **32** [11], 84 (1929).—M. gives a general description in reference to the German gypsum industry. F.P.H.

Old mortars. K. BIEHL. *Tonind.-Ztg.*, **53** [22], 449–51 (1929); *Rock Prod.*, **32** [10], 105 (1929).—B. presents the results of analyses of six different samples of old Roman mortars of the years 100 to 400 A.D. and of a German mortar of the year 1760. F.P.H.

PATENT

Manufacturing aluminous cements. ERNEST MARTIN. U. S. 1,716,527, June 11, 1929. In the manufacture of aluminous cement, the step of incorporating with the aluminous cement-forming mixture before heating of a catalyzer consisting of a small proportion at least of chloride of soda whereby to facilitate formation of hydraulic aluminates.

Enamels

Cause and control of color variation in cast-iron and sheet-iron enamels. W. F. WENNING. *Jour. Amer. Ceram. Soc.*, **12** [7], 491–93 (1929).—The need of uniformity and high quality in color chemicals for enamelware becomes more important with the constant demand for colored enamelware. The influence of opacifiers, enamel composition, and firing temperature on enamel colors is pointed out.

A deformation study of cobalt oxide-iron oxide-silica mixtures. JOHN F. SHEPHERD. *Jour. Amer. Ceram. Soc.*, **12** [7], 494–97 (1929).—Deformation eutectic fusions are reported for 46% Co_3O_4-54% Fe_2O_3 and 36% Co_3O_4-42% Fe_2O_3-22% SiO_2. Either of these eutectics could be substituted for cobalt as an enamel ground coat.

Utilization of waste pickling solutions. ANON. *Emaillewaren-Ind.*, **6** [19], 152 (1929).—With sulphuric acid the problem is easily solved since only a large container is needed for collecting the solution. By the suspension of scrap iron the free acid is converted to sulphate and after an elapse of time the liquid may be evaporized by means of steam coils and the sulphate crystallized out or left to itself until deposited. The salt is salable. The use of waste muriatic acid pickling solution is more difficult, but it can be converted to chlorides or oxides. In large operations the utilization may amount to one-half of the cost of the muriatic acid. Wire works are doing this effectively. T.W.G.

Enameling of sheet steel. III. Smelting of enamels. WALTER SCHULZ. *Ceram. Ind.*, **12** [6], 663–66 (1929).—The rotary smelter is preferred if oil is cheap, or if the smelter is only used for a few days of the month. The oil is atomized best by low-pressure air (500 to 600 mm.); steam and high-pressure air are not only too expensive but carry away too many light particles of the enamel on account of the high pressure. The consumption of oil per heat is about 22 to 25% of the weight of the mixed enamel

batch. The smelting heat for ground coats is about 2050 to 2200°F; for white and colored enamels, 1900 to 2100°F and for special hard one-coat gray enamels up to 2500°F. The time of smelting varies with the heat and the size of the batch. When the weight of the mixed batch varies between 400 to 1000 lbs., the smelting time is usually between 1 to 3 hrs. The principle of smelting enamel is the same for all types of furnaces. The hoppers containing the mixed enamel are run on overhead monorails over the entire battery of smelters. The enamel is dumped through a funnel in the feeding opening of the smelting onto the hearth and then leveled. Now the heat is turned on and will slowly rise from 1500 to 1600°F, up to the required heat of 1900 to 2300°F. The enamel in the stationary smelter has to be stirred, after it is soft enough, about every 20 to 30 min. At the end of the smelting, samples of the enamel are taken with an iron rod. When the string of enamel running down from the rod is smooth enough, the batch is tapped. In the first part of the smelting operation, the enamel gets soft and is like a viscous dough, then it starts boiling and develops bubbles all over its surface. It is losing its viscosity more and more and can be stirred easily with an iron rod. Finally, all bubbling ceases except in a spot of about 5 in. in diameter on the surface. At least the enamel is at rest and forms a smooth glassy surface in the smelter. A test taken out of the smelting operation at this time will, if the enamel has been homogeneously mixed, be free from knots or pimples. If this test were made somewhat earlier, when the enamel surface still showed bubbles, the string would contain knots. If a string sample is rough and full of knots, the enamel is not yet ready for tapping. An exception of this rule is the enamel containing higher amounts of antimony oxides which make the enamel very viscous. In this case the enamel will be tapped even if the string sample is yet rough and contains quite a few bubbles; otherwise, the antimony enamels would lose their opacity and would be oversmelted. For Part II see *Ceram. Abs.*, **8** [6], 399 (1929). F.P.H.

Fundamentals in sand control. ANON. *Cement, Mill & Quarry*, **34** [6], 29 (1929).—The character of sand is quickly changed when the new is mixed with the used material. Since sand free from clay, as well as clay for reviving the bond, are now generally used in some quantity, special specifications for these are now needed. Careful sand control actually fixes the number of jolts within narrow limits in making molds. E.P.R.

Carburizing with mixtures of hydrogen and natural gas. W. P. SYKES. *Fuels and Fur.*, **6** [7], 913–18 (1928).—Tables of data and a series of photomicrographs are included. A.E.R.W.

Magnets as testing tools. R. L. SANFORD. *Sci. Supp.*, **69**, 14 (1929).—Magnetism, working silently and without injuring the metal, is coming more and more into industrial and research use to detect flaws, to inspect welds, and to insure quality. H.H.S.

Enameling of cast iron. A. MÜLLER. *Giesserei Ztg.*, **26**, 158–60 (1929).—Cast iron that is to be enameled should analyze: Si 2.3–2.6, Mn 0.6–0.9, P 0.6–0.9, S 0.08–0.1, C 3.6–3.7%. Of these, C has the greatest influence on enameling. The influence of C, P, Si, S, and Mn is discussed briefly. (*C.A.*)

BOOKS

Elementary Foundry Technology. L. A. HARTLEY. McGraw-Hill Publishing Co., Ltd., London, 1928. Price 15*s.* net. Reviewed in *Mech. World*, **85** [2210], 438 (1929).—This book makes special reference to gray iron and steel, and is, in part, a collaboration of men who are well qualified to deal with the subject. The structure of materials, physical properties, reduction processes, and effects of certain elements on iron are dealt with. In view of the recent advance in knowledge and research on the effect of mixing iron with other substances, this feature forms a noteworthy part of the book; the related consideration of mechanics, electricity, and light is also given attention. In an ele-

mentary way the volume forms a complete treatment of the principles and practices of foundry work. E.P.R.

Foundryman's Handbook. Penton Publishing Co., Cleveland. Price $6.00. Penton Publishing Co., Ltd., London. Price 30*s*. Reviewed in *Abrasive Ind.*, **10** [6], 37 (1929).—In 1922, the first edition of this volume constituted the first compilation of selected foundry data to be offered to the industry. The present edition has been revised carefully and much of the older material which now is obsolete or seldom referred to has been eliminated. Much new material has also been added. The book is divided into nine general sections under which the subjects have been classified to facilitate reference. (1) Miscellaneous foundry data: this includes cupola practice, composition of gray iron castings, pressure exerted by molten metal, pickling solutions, chimney design, etc., (4) relates to nonferrous metals and alloys which are described under 58 topical heads, (5) specifications are covered and deal with gray iron, steel, malleable cast iron and nonferrous metals and alloys, (6) care and maintenance of equipment, (7) routine analyses; methods covered in this section include those for gray cast iron, steel, manganese, bronze, coke, limestone, slags, and ferro-alloys. A new innovation in a book of this type is the inclusion of a lexicon of all technical terms. These definitions constitute (8) and include practically all terms referred to at the present time in foundry and metallurgical practice. (9) Collection of miscellaneous tables and information such as conversion tables, weight of a square foot of various metals, microscopic examination of cast iron, Brinell hardness numbers, etc. E.P.R.

PATENTS

Metal tile. JAMES C. DE VOL. U. S. 1,716,626, June 11, 1929. A metal tile formed of a metal plate having rearwardly projecting flanges disposed at substantially right angles to the face of the plate, each flange having relatively narrow attaching tongues disposed at one side of the center thereof and a correspondingly positioned recess on the opposite side of the center, the tongues having perforations therein positioned so that attaching nails are positioned in the space between the flanges of adjacent tiles with the ends of the tongues engaging the recesses in the flanges of adjacent tile thereby permitting a mortar joint of the tiles having bonding relation to the foundation upon which the tiles are mounted.

Enamel with a cement base. J. PEETERS. Belg. 352,464, July 31, 1928. The enamel is formed of a mixture of cement, $CaCO_3$, and coloring oxides rendered liquid by addition of an aqueous rosin emulsion. After being coated with this enamel, the objects are heated in a closed vessel. (*C.A.*)

Glass

Application of nepheline-syenites of the Murman Coast in glass industry. W. WARGHIN. U. S. S. R. Scientific-Technical Department of the Supreme Council of National Economy, *Trans. Ceram. Res. Inst.* [Moscow], No. 15, 58 pp. (1929).—Difficulties which arose with alkalis caused the Government Ceramic Institute at Leningrad to study the use of alkali containing rocks in glass. The nepheline-syenites of the northeast coast of Lapland (Russian Murman Territory) are especially important for the northern and northwestern parts of the Union; the content of alkali (15 to 16%) of these rocks, as well as their chemical composition, is very similar to the best varieties of German phonolythes. The deposits of syenite in the Murman region are very extensive; the Hibin massive consists mainly of these rocks. Considerable accumulations of these rocks of great purity and constant composition are found in the form of boulders, gravel, and sand; great advantages may be obtained from the use of this material. A series of analyses of different samples of these rocks was made. W. gives a brief statement of the current literature on the question of

the use of these rocks in the glass industry and refers to the excellent quality of the articles manufactured (chemical and thermal properties, as well as the capability of resistance of the glass). Its use is economical. To determine the most favorable proportions of the rocks in the batch, the Government Ceramic Research Institute made systematic tests in the Institute itself, and in glass works. The test melts were made in a glass melting furnace (heated with wood) of medium size. Glass was melted in a crucible with a content of about 3 kg. Two bottles were blown. The following conditions were considered during the melting of the glass: easy fusibility, degree of perfection of clearness, convenient manufacture, tendency to devitrification and other circumstances of the operation. All the trial melts were divided into the following series: (1) One series of batches was composed of nepheline with a gradually increased addition of sand and lime but without sodium or sulphate. This series consisted of glass containing from 55 to 68% of SiO_2 and from 13 to 25% of CaO, with a corresponding amount of alkalis and alumina existing in the nepheline. In one series of batches the influence of a small addition of sulphate and arsenic (1%) on the process of purification of the glass was taken under consideration. Batches in which one part of lime was replaced by magnesia were also melted. (2) One series was to establish the influence of the chief ingredients, silica, alumina, lime, and alkali, on the quality of the glass. During these test melts silica was gradually replaced by alumina, and alkalis by lime. The batches were composed of nepheline, sand and lime, with or without the addition of alkalis. Several batches were melted without nepheline for comparison. The glass of this series was tested with regard to its chemical power of resistance to water, a solution of sodium and different acids. (3) As the iron of the nepheline-syenites (2 to 3%) is not distributed but is only in dark-colored minerals (about 10%), the dressing by magnetic separation is possible. Glass with a content of 0.30 to 0.45% of Fe_2O_3 was obtained. (4) Several melts were made in "Drujnaya Gorka" and "Torkowichi" glass works of the Leningrad Glass Trust. Batches containing only nepheline-syenite, sand, and lime were melted, as well as those into which a certain amount of sodium and sulphate also was put. Different objects were blown from the glass obtained (bottles, wine-glasses, etc.), which showed high chemical and thermal qualities, as well as a high degree of mechanical resistance. W. draws the conclusion, based on the tests, that the nepheline-syenites of the Murman coast offer excellent material for use in the glass industry. The conditions for a normal batch with a small addition of alkalis are as follows: (1) Introduction of the highest possible quantity of nepheline on condition that the content of alumina in the glass does not exceed 15%. (2) Addition of sand only in the amount absolutely necessary for obtaining acid-proof glass; the silica content should be not less than 57 to 58%, and the total $SiO_2 + Al_2O_3$ not less than 70% (for high grade acid-proof glass even more, 60 to 65% SiO_2). (3) Introduction of sodium (or a corresponding amount of sulphates) in the proportion of 25 to 30 parts of sodium per 100 parts of sand. (4) Introduction of a greater quantity of lime. (5) Introduction of a smaller quantity (0.3 to 0.5%) of sulphate in order to accelerate and improve the purification process in the glass. To make the production of glass more economical, batches without alkalis may be used, but these ingredients must be replaced by sand and lime. In this case the glass obtained will correspond to the qualities of the glass used for champagne bottles, which requires special conditions of melting and manufacturing. In conclusion, a series of economic calculations and considerations on the use of the nepheline-syenites of the Murman Coast are given. Tables showing the chemical analysis of nepheline-syenites of the Murman coast, as well as those showing the ingredients of 79 samples of nepheline glass, are given. W.A.

Physical properties of glasses and their relation to composition. Mechanical properties of glasses. II. G. GEHLHOFF AND M. THOMAS. *Glass Ind.*, **10** [6], 139–44

(1929).—The alkalis seem to increase the impact strength slightly. There was not a characteristic relation between potash and soda in mixed alkali glasses. With the divalent glass formers it was very difficult to obtain data. CaO, ZnO, BaO, and PbO seem to have only a slight influence, while an addition of MgO up to 10% considerably raised the impact strength. The only great change in the impact strength with varying composition is that for boric acid glasses. The impact strength increases considerably up to 15% B_2O_3 and then decreases again; Al_2O_3 also seems to increase the impact strength up to a certain per cent. The effect of Fe_2O_3 cannot be recognized. The Martens diamond hardness indicator was used as this made it possible to have a diamond act on a glass plate with constant pressure and in the same direction. The glass plate is drawn under the diamond by a carriage. The conically ground diamond with a cone angle of 90° produces scratches on the plate that vary in depth according to the hardness of the glass and therefore vary also in width on account of the conical shape of the diamond. The width of the scratch can be easily measured under the microscope with an ocular micrometer. The alkalis reduce the scratch hardness very greatly, just as in each case the alkalis exert the strongest influence on the physical and chemical properties. Soda glasses are softer than potash glasses. In mixed glasses containing both alkalis, the scratch hardness has a pronounced minimum. MgO, ZnO, and BaO considerably increase the scratch hardness. BaO increases the scratch hardness, and PbO reduces the scratch hardness only moderately, both contrary to general opinion. By the introduction of only a few per cent B_2O_3 glasses become mechanically very hard, this being confirmed by the scratch hardness test on boric acid glasses. In glasses with increasing boric acid content the hardness increases only to 15% B_2O_3. On increasing the boric acid content further the scratch hardness decreased just as rapidly as it rose. This maximum in the scratch hardness at about 15% corresponds to a maximum in most of the physical and mechanical properties at this percentage. Al_2O_3 and Fe_2O_3 slightly increase the scratch hardness. The measurement of the modulus of elasticity was made by bending in the usual manner, using a rod resting on stump knife edges 20 cm. apart. The loading was done by means of a stop arrangement which made it possible to load each rod in the center uniformly and without vibration. The weight of load was 100 g. Glasses with increasing alkali content show falling moduli of elasticity; potash decreases the modulus of elasticity more than soda. The modulus of elasticity of mixed glasses is not the sum of the values for glasses with only one alkali. Here there is no pronounced maximum or minimum as is found in any of the other properties. As in all properties, so also with the modulus of elasticity, CaO exerts the strongest influence; the modulus of elasticity increases strongly with the increasing CaO content. Increasing MgO, ZnO, and BaO, increases the modulus of elasticity although not to the same extent as CaO. PbO increases the modulus of elasticity only very slightly. As with all the other properties, boric acid glasses at about 15% B_2O_3 show a maximum here. The modulus of elasticity rises abruptly to this percentage and then falls just as rapidly. Fe_2O_3 and Al_2O_3 caused a slight increase in the modulus of elasticity. The results of the experiments are summarized. For Part I see *Ceram. Abs.*, **8** [7], 490 (1929). E.J.V.

Ultra-violet ray transmitting glass. PEEMÖLLER. *Diamant*, **50** [31], 639–41 (1928).—Some of the different types of ultra-violet ray transmitting glasses are mentioned and their properties are outlined in a general way. E.J.V.

Studies of borosilicate glasses. ARNOLD COUSEN AND W. E. S. TURNER. *Glastech. Ber.*, **6** [8], 393–410 (1928).—The favorable properties which boric acid imparts to glass, such as chemical resistance, and ability to withstand sudden changes in temperature, are very narrowly defined by the glass composition. The work of Zschimmer, Gehlhoff and Thomas, and English and Turner bears testimony of this fact. Investigations of

a series of glasses containing boric acid and up to 57% silica are reported. The melts were made in a platinum crucible in a small gas furnace. During the melting process much boric acid evaporated (more than 30% silica diminished this loss). The glasses containing boric acid showed marked deviations in the coefficient of expansion, depending on the past heat treatment of the glass. The expansion follows a straight line until the lower critical point is reached. The results of the experiments were tabulated. The density of molten boric acid (averaging 1.8442 at 25°C) and that of borosilicate glasses were accurately determined. The samples were tested in the form of small beads, to exclude the effect of surface moisture. They were cooled carefully, because otherwise the density figure becomes very low. E.J.V.

Value of soda in glass melting with special reference to conversion into dust. ANON. *Amer. Glass Rev.*, **48** [35], 15 (1929).—The single factors will vary according to the method of production of the soda and will take on various values, *e.g.*, a Leblanc soda will, as a rule, show a higher percentage content of impurities than an ammonia or Solvay soda. Generally the content of Na_2CO_3 can vary in the case of the first-mentioned soda between 70 and 99%, whereas in the case of an ammonia soda it will seldom fall below 98%. The "grade" is made by titration of the soda with hydrochloric or sulphuric acid and methyl orange and recalculation of the results of titration for Na_2CO_3. There is no objection to this process with Solvay soda, but in the case of Leblanc soda it may lead to considerable error. Impurities in an ammonia soda are as a rule of subordinate importance, and their composition is almost constant in the course of various deliveries. The normal content of moisture of a soda should not exceed 1% in deliveries. A current check on an ammonia soda over several years showed little variation from this value. Even after a rather long but proper storage the water content of a good ammonia soda increases but little, whereas storage of the Leblanc may bring about bad results. Soda is classified as light or heavy soda, according to the weight per unit volume; for heavy soda about 0.9 kg. for 1000 cc. (lightly shaken down) and 1.1 kg. for 1000 cc. (packed down solidly). The main emphasis in the determination is usually laid only on the chemical composition and quite erroneously the weight per unit volume and the granulation are but little considered. In composition and in origin there is usually no difference between the two kinds; both the light and the heavy soda can be made by the Solvay process. The difference in production is merely in the duration and intensity of the calcining process. Of much more importance than the weight per unit volume is the capacity for conversion into dust which with a light soda is, as a rule, much higher than with a heavy one and shows itself in the preparation of the mixture and during the placing of the mixture in the vat and to a lesser degree in the pot. The dust which is precipitated in the mixing chamber may consist of up to 60% of soda, a loss of raw material which may seem small but which in the course of time may amount to a very considerable sum. The combustion gases carry along the light particles of the mixture to the most remote parts of the furnace. All the parts touched are rapidly corroded. Analyses of a fresh dust mixture from a chamber showed in one specific case over 88% of water soluble material with alkaline reaction and with a very high Na_2O content; a dust, taken from the air tap, showed over 50% and a dust from the neighborhood of the flue likewise showed over 50% of water soluble material with alkaline reaction. From this the importance of weight of the separate soda grain is seen. E.P.R.

Speed of crystallization of soda-lime-silicate glasses. E. ZSCHIMMER. *Glastech. Ber.*, **6** [10], 572–79 (1929).—The results of measurements of the speed of crystallization of the system sodium oxide–lime–silica, confined to the range of technical glasses, are given. The measurements were entered in a 4-dimensional diagram. The melts, which varied in soda and lime content, were made with chemically pure raw materials in a platinum crucible. The investigation shows especially the influence of lime on the

speed of crystallization. Curves were drawn representing the duration needed for the formation of crystals of equal size (isochrones) and the temperatures of maximum crystallization speed (isotherms). The tabulated results allow the calculation of the amount of devitrification at certain temperatures and with certain glass compositions. Further work of the silicate laboratory of Karlsruhe on the effect of magnesia, alumina, and potash on the crystallization speed will give data about these important questions. The practical application of these investigations is obvious. E.J.V.

Influence of aluminum and magnesium on the crystallization of glass. I. I. KITAIGORODSKY. *Ceram. Ind.*, **12** [6], 647 (1929).—The presence of Al_2O_3 in glass does not in all cases reduce the crystallizability. Under an increasing content of alkalis, the crystallizability decreases if other auxiliary restrictions remain constant. Those kinds of glass, which contain many different constituents, have comparatively small crystallizability. The content of CaO should not exceed 10%; also when there are other constituents in the glass, among them Al_2O_3. The crystallizability decreases with a decreasing content in CaO. But those kinds of glass, in which in the presence of not more than 14% alkali the content of CaO does exceed 11%, show a high crystallizability. The crystallizability is not weakened by the substitution of SiO_2 by Al_2O_3 or by Al_2O_3 and MgO. Glass, in which Al_2O_3 is absent, shows under a constant content of CaO the greatest crystallizability at the lowest alkali content. The crystallizability in a normal glass is increased by substitution of CaO with MgO, in case MgO is introduced as magnesite. F.P.H.

Research on the vitreous state. MICHEL O. SAMSOEN. *Bull. soc. encour. ind. nat.*, No. 3, 185–204 (1929).—S. gives thermal dilatation curves for bottle glass (SiO_2, 69.3; Al_2O_3, 2.2; CaO, 13.0; Na_2O, 14.1; Fe_2O_3, 1.0; MnO, 0.3%), an enamel (B_2O_3, 23.9; PbO, 76.1%), a glass containing B_2O_3, 93.3% and Na_2O, 6.7%, and boric anhydride (B_2O_3). The following coefficients of linear dilatation ($\times 10^6$) of B_2O_3 are given: 0°C., 14.30; 50°, 14.75; 100°, 15.18; 150°, 15.65; 200°, 16.12; 230°, 16.41; 250°, 179.12. In all of the above cases there is regular dilatation until a certain temperature, several dozen degrees below that of deformation, is reached. The dilatation is then considerably increased. Thermal dilatation curves for several organic glasses showed the same presence of a transformation point in each case. By means of the proper apparatus it was possible to determine the cubical dilatation of B_2O_3 and the results were as follows: 100°, 45.54; 150°, 46.95; 200°, 48.36; 240°, 49.80; 250°, 615.2; 300°, 627.9; 330°, 629.4; 360°, 631.5 $\times 10^{-6}$. The change in expansion seems to be an allotropic transformation. Calorimetric measurements showed that in the case of commercial glasses there was always absorption of heat followed by an increase of specific heat. B_2O_3 shows a discontinuity in its specific heat curve at 218° corresponding to a heat of transformation of about 2.3 calories. The specific heat changes from 0.32 below 218° to 0.34 above. The following results were obtained for a series of glasses of the system Na_2O–SiO_2:

SiO_2 (%)	Coeff. of dilatation at 20°C	Transformation temperature (°C)	Coeff. of dilatation after transformation
49.2	12.61×10^{-6}	420	83×10^{-6}
53.0	15.55	390	72
55.0	18.78	345	65
57.0	18.52	355	60
60.0	15.50	420	59
63.0	13.80	445	50
66.2	13.45	460	42
70.0	12.85	355	37
76.0	11.06	350	32
82.5	10.02	420	20
85.3	9.05	445	17
92.0	7.07	540	11

It is evident that the additivity law which is frequently used for commercial glasses is not even approximated. The curve plotted with transformation temperatures as ordinates and per cent SiO_2 as abscissas shows a maximum at 460°, corresponding exactly to the composition of $Na_2O \cdot 2SiO_2$. The success of Schott's additive rule is due to the fact that definite compounds and pseudo-eutectics are absent in the field of commercial glasses. S. concludes that there is for all bodies existing in the vitreous state a temperature or temperature-interval during which a transformation occurs and manifests itself by discontinuities in all physical properties. The transformation temperature seems to depend only on the viscosity and the transformation occurs when the viscosity is $10^{12.7}$ poises. A.J.M.

Pressing glass. ROY E. SWAIN. *Glass Ind.*, **10** [6], 135 (1929).—Glass pressers have more complex problems than do the blowers. Many of these have been solved in conjunction with the mold maker and the mold designer. Standards of pressing equipment vary with the different factories or districts. To align the mold ring and plunger on the press is a delicate task. The mold ring and plunger must be aligned on the same axis and the height of the plunger must be adjusted so that the plunger seats comfortably in the mold when the rocker arm is set on dead center. In many cases it is also necessary to align the mold, ring, and plunger radially in order that the design may be produced exactly as planned. The molds are usually below good working temperature when first aligned. It is often necessary to make adjustments to take care of the expansion of the molds as they become heated. Neglect of this may permit the plunger to rub the ring on one side and throw all the clearance to the other side of the mold which may allow a flash or fin form. This condition will cause permanent damage to the ring and plunger in time. Much responsibility also rests upon the gatherer. He is expected to gather a clear piece of glass of accurate weight and shape and so handle the viscous mass as to be able to place it in the proper place in the mold. Possible causes of defects are discussed. E.J.V.

Polishing of glass surfaces. ANON. *Abrasive Ind.*, **10** [5], 36–37 (1929).—A method whereby the operations of grinding and polishing glass surfaces, particularly plate glass surfaces may be completed substantially more rapidly than heretofore has been perfected by Josef Pivin, Duren, Germany. The difference from the known methods resides in the interpolation of a separate polishing operation, *i.e.*, a preliminary polishing operation with separate polishing tools. The preliminary polishing is effected in a considerably more energetic manner than is possible with polishing red. After the preliminary polishing the final brilliant polish is obtained with the aid of polishing red. The same polishing tool is not employed. Considerable economy in time is achieved because it is not necessary to wash out the polishing tool carefully between the operations. The entire polishing operation occupies only 37 min.; 18 min. for the coarse and fine grinding making a total of 55 min. which, compared with the 108 min. of the previous method, represents a reduction of one-half. The method of the present invention may also be applied to the continuous grinding and polishing process. Apart from the reduction in the total period of the operation, the length of the tables may be materially reduced in consequence of the reduction in the number of polishing tools so that the machine occupies considerably less space, is more easy to construct, and requires less power. E.P.R.

Flexible glass polishers. K. T. *Diamant*, **50** [36], 741 (1928).—A description of a new Siemens glass polishing machine, having several polishing disks on which different polishing media can be used, is given. The power equipment and speed of the various disks is discussed. E.J.V.

Luminescence in glass and fused silica vessels. L. F. BROWN. *Science*, **69**, 191 (1929).—Discussing Lemcke's results (see *Ceram. Abs.*, **8** [6], 404 (1929)), B. states that

he is examining the effect on the luminescence when certain gases and solids are present. The working temperature is 30°C. H.H.S.

New processes in glass production. O-ST. *Diamant*, **50** [24], 501–502 (1928).—A brief discussion is given of some of the recent developments in glass production, such as the Libbey-Owens and Fourcault methods of producing sheet glass, the drawing of a continuous strip of sheet glass by the method patented by Jules Hanappe of Courcelles, Belgium, the investigation of the solubility of glass components by Walter Meyer, and the production of laminated glass. E.J.V.

Development of silver mirrors. MAX ERMES. *Diamant*, **50** [13], 276–77; [15], 311–12; [23], 480–82 (1928).—A detailed discussion of the development of the process of silvering mirrors, starting in with the old methods employed for this purpose and tracing their changes to present-day methods. E.J.V.

Innovation in glassworking. M. P. *Diamant*, **50** [31], 644–45 (1928).—A summary of some of the newer mechanical devices introduced into the field of glassworking is given. E.J.V.

Flat glass furnaces. H. K. HITCHCOCK. *Fuels and Fur.*, **6** [7], 939(1928).—(Presented at Spring Meeting, A.S.M.E.) The various processes used in making flat glass, both from tank and pot furnaces are discussed. Up to the beginning of the 20th Century all flat glass came under the heading of (1) crown glass, made by rapidly whirling a hollow sphere of glass on an iron rod, (2) window glass, made by blowing into a hollow cylinder and afterward flattening it into sheet form, and (3) plate glass, made by rolling the glass on a metal table. Most of the window glass made today is drawn from the tank in sheet form by one of three processes. One very successful process for casting continuously from a tank consists in forcing a stream of molten glass through a refractory slot, immediately passing it through a pair of rollers to give it more accurate dimensions and then passing it into a continuous leer. Ribbons of glass are now made up to 10 ft. in width and hundreds of feet in length. Accurate temperature control in the leers is of greatest importance and a series of thermocouples is used to record temperatures in all parts of the leers. Auxiliary heaters are so placed that they may be used to prevent fluctuation in temperatures. A description of various methods used is included. A.E.R.W.

Recent developments in glass furnaces and leers. S. R. SCHOLES. *Fuels and Fur.*, **7** [2], 197 (1929).—Fire conditions, temperatures, rate of block corrosion, and the technique of operation, have all changed to meet the new requirements in tonnage. Increased temperature has resulted in the omission of tongue-tiles so that the gas and air now have 4 ft. or more of mixing space before entering the furnace. Modern conditions require larger port openings. This has relieved draft conditions, lessened the velocity of the flames, and allowed a surplus of fire capacity for periods of necessary forcing. The ratio of port area to melting area has been brought up to 1:22. Increasing the height of regenerators has increased the capacity and allows more uniform heating of checkers. Porous fire brick of open structure in checkers is giving way to the choice of dense fire brick of higher capacity and conductivity for heat. Insulation of regenerator chambers is a paying investment. Modern refractory tile of high heat conductivity and improved cements for providing tight joints are doing much to aid recuperators. Recent developments in tank block manufacture are: (1) the recognition of the great value of low porosity secured by better methods of handling the raw mix and higher and longer firing, and (2) the identification of mullite as the most stable alumina-silica compound and its application in bonded or cast form. The use of silica brick and shapes is standard practice. New design in melting chambers tends toward long, narrow, and shallow shapes. The depth commonly chosen is 18 in. The trough form of melter seems to decrease channeling in the center of the tank and decreases the zones of slow movement

or stagnation at the sides and bottom. The trough form of tank has increased the quantity of clear glass per unit of area. The flexibility, low repair cost, and rapid rate of bringing into service are in favor of the trough tanks. One recent development in throats is the use of depressed, sunken, or "submarine" throats. This type of throat lessens the rate of cover-block corrosion by providing cooler glass. It also secures a greater depth of glass above the throat and this deeper "skim" is held to improve quality and increase capacity. The "dog house" is being superseded by a charging device which is arranged to supply by screw conveyer a steady stream of mixed batch and crushed cutlet through a cooled pipe to the tank interior. The chief advantages are a saving in labor and a steady rate of feeding. Recent developments in annealing have placed this process on a scientific basis. Cast iron as a material for muffle walls, web conveyers, forced draft, and temperature control by regulated dilution of flame gases with air, and complete insulation are the outstanding features of new leers. The unit leers with the new small tanks equipped with one feeder and one machine each, may bring about a change in factory arrangement. A.E.R.W.

Old glass. ANON. *Nat. Glass Budget*, **45** [4], 18 (1929).—The city of Washington sells its salvaged bottles for from 75c to $4.50 a gross. Broken glass, which is also reclaimed by the freight carload, brings $6 a ton when eventually consigned to glass factories which use it as raw material in manufacturing glassware, window glass, containers, etc. The bottles at the Washington establishment are transported on an endless conveyer from the main building to the subsidiary glass salvage plant. As the flow of bottles passes the expert pickers, they remove the different sizes, shapes, and varieties. The bottles are then packed in crates and barrels and delivered to professional junk dealers. The broken glass is loaded directly into gondolas of 300 bbls. capacity. E.P.R.

Progress of glassmaking in the States. W. E. S. TURNER. *Glass Ind.*, **10** [6], 131–35 (1929).—Changes in the $4^1/_2$ years since T.'s last visit have been far-reaching. Steady improvement has been made in batch compositions. While there has been no change in the machinery used for mixing the batch there is a keener perception of the factors which influence the homogeneity of the batch. The changes in methods of pot making have been minor. One tendency is the use of foreign clays in the materials which the pot makers employ. The introduction of specially refractory materials using sillimanite, andalusite, and mullite for glassmaking purposes has lagged behind the discussion devoted to them. The electrically-fused and cast mullite blocks made by the Corhart Co. are discussed. Experiments with furnace building have begun to be interesting. The old types of gravity-fed machines do not seem to have changed substantially. The new Knox-O'Neill machine, the Corning Glass Works machine for the manufacture of electric light bulbs, the modified Westlake machine, and the Ivanhoe machine are among the newer developments. The manufacture of sheet glass is the one in which the most substantial changes are being made at the present time, with the Libbey-Owens process thoroughly established but with the Fourcault process gaining. In the annealing process nearly fuelless leers have come into use. E.J.V.

Illinois Glass Co., Bridget, N. J. ANON. *Ceram. Ind.*, **12** [6], 642–47 (1929). F.P.H.

New plunger in glassware plants. ANON. *Amer. Glass Rev.*, **48** [33], 13–14 (1929).—The Miller Foundry Co., Columbus, Ohio, has announced the production of a very successful plunger for use in the manufacture of glassware. E.P.R.

Ford motor reported planning larger plate glass machines. ANON. *Amer. Glass Rev.*, **48** [34], 22 (1929).—The plate glass division of the Ford Motor Co. has plans for a new type of melting unit for production of plate glass. An experimental tank will be erected and if it proves successful there is a strong possibility that the continuous method

of plate glass production as used by the Ford Motor Co. will be changed entirely. The new unit would supply a ribbon of glass 90 in. wide. In order to take care of this, new and larger automatic grinding and polishing units would have to be developed. If the new unit works as expected, it is probable that two units of the larger type will replace four units of the type at present in use. E.P.R.

Electric annealing. J. FRAZIER. *Nat. Glass Budget*, **45** [3], 5 (1929).—An address delivered at the Industrial School held by the Ohio Power Co., at Canton, Ohio. E.P.R.

History of the glass industry. ANON. *Diamant*, **50** [23], 477–80 (1928).—A brief contribution to the history of the glass industry, starting with the formation of the first guild in the 15th Century and tracing it to the present day. Little detailed information is presented. E.J.V.

History of the Spectacle Makers' Company. T. H. COURT AND M. VON ROHR. *Chem. News*, **138**, 332–33 (1929).—(Meeting Optical Soc., May 9.) The Company's charter is dated 1629, but the books prior to 1666 were burnt in the great fire of London. The first spectacle shop to be opened was that of John Marshall in 1675; it improved the status of spectacle makers, as they became opticians and came into contact with scientists. A comparison of the societies of Nuremberg and London is made. H.H.S.

Development of the Canadian glass industry. ANON. *Pottery Gaz.*, **54** [624], 960–61 (1929).—Prior to 1878 glass production was a small business. For a long time the Province of Ontario was the center of Canada's glass industry but now some of the other Provinces are entering into competition with it. A new plant is being erected on the Pacific Coast. There are some 54 various glass plants in Canada, and more are being developed. E.J.V.

Belgian glass industry. ANON. *Ceram. Age*, **12** [6], 243–45 (1928); *Commerce Reports*.—(1) *Plate glass.* The situation in the plate glass plants remains satisfactory. Orders on hand cover the rate of output. Marketing and competition problems are simple, the former being handled by a central agency. Competition from sheet-glass plants is largely prevented by a trade agreement. (2) *Blown window glass.* The trade is becoming precarious, demand is poor, and prices variable. Even photographic glass will soon be made largely in mechanical mills. (3) *Drawn glass.* The general situation has improved, prices are maintained or raised and large orders are on hand. The Comptoir has reduced production by about 20%. If the new Lambert mill remains outside the Comptoir, four independent mills will be in production. The Comptoir appears to be operating more smoothly. Details regarding its methods and accomplishment are given. A.E.R.W.

Chile to make flat glass. ANON. *Nat. Glass Budget*, **45** [3], 24 (1929).—The Chilean government on June 1, will receive tenders for the establishment of a flat glass industry in Chile. E.P.R.

Goethe and stained glass. GAHLEN. *Diamant*, **50** [31], 644–46 (1928).—A reprint of Zschacke's article from *Glastech. Ber.*, **6** [2], 89–96 (1928); see also *Ceram. Abs.*, **7** [11], 750 (1928). E.J.V.

Chemical surface treatment of glass. W. MINDT. *Glas- und App.*, **9**, 11 (1928).—A general article dealing with etching media and the action of these, methods of use, advantages and disadvantages of the chemical treatment of glass, special etching processes such as ice and line etching and acid polishing. (*J.S.G.T.*)

Adsorption of gases by glass walls. V. Carbon dioxide. M. CRESPI. *Anales soc. españ fís. quím.*, **27**, 108–19 (1929).—The system of tubes used heretofore has been replaced by a system of small ampoules having a total volume equal to the volume of the largest ampoule used for comparison. Determinations were made with very pure CO_2, giving for adsorption per cc. $A_s = 0.93 \times 10^{-8} \times p^{0.444}$ g. between 1 and 0.25 atmos-

pheres at 13° and $A_e + 0.025 \times 10^{-6} = 1.77 \times 10^{-5} \times p^{95.77}$ between 1 and 0.062 atmospheres. At low pressures there is deviation from the exponential law. With a 1 liter bulb under ordinary conditions the CO_2 absorbed is 0.000086 g. Expressed in molecules this is of the same order as was found for $CHCl_3$. It was again verified that the error in density determinations increases the less the volume of the container and the less the pressure. (*C.A.*)

The manganese equilibrium in glasses. WILDER D. BANCROFT AND R. L. NUGENT. *Jour. Phys. Chem.*, **33**, 481–97 (1929).—Information on the coloring effect of Mn was obtained from quantitative experiments on the chemical behavior of Mn in the borax bead. The pink-violet color of Mn is due to tervalent Mn; Mn in the colorless bead is bivalent. The equilibrium of bivalent and tervalent forms is affected by temperature, O_2 pressure and acid or alkaline quality of the melt. Litharge-boric acid-Mn system examined quantitatively also showed definite shift of color like that with the borax bead. The Na_2O–P_2O_5 system gave a qualitative indication of color shift. The study was extended to reactions in glass; prolonged exposure to light produces violet color in glass which may be due to the shift of Mn^{++} to Mn^{+++} under the influence of light. The coloration of rose quartz is also considered. (*C.A.*)

Absorption of ultra-violet glasses. C. WINTHER. *Z. wiss. Phot.*, **25**, 230–32 (1928).—Curves given show the ultra-violet transmission for a number of specimens of ultra-violet glass and of ordinary plate glass. Variation of thickness of the glass specimens was adjusted by altering the exposure time according to the method of Henri. (*C.A.*)

Influence of boric oxide on the dispersion of optical glasses in the near infra-red. T. DREISCH AND P. LUEG. *Z. Physik*, **49**, 380–85 (1928).—The n to 6 significant figures has been determined for a number of optical glasses, with and without a B_2O_3 content, in the range 0.5–2.5 μ; the difference between the index for 1.47 and 2.39 μ is approximately proportional to the boric acid content. (*C.A.*)

Value of different types of glass for transmitting ultra-violet light. EDWIN T. WYMAN, ARTHUR D. HOLMES, LAWRENCE W. SMITH, DONALD C. STOCKBARGER AND MADELEINE G. PIGOTT. *Amer. Jour. Diseases Children*, **37**, 473–82 (1929).—Corning glass is practically transparent to the ultra-violet radiations which are effective in the treatment of rickets. Vitaglass is comparatively less transparent, and ordinary window glass, opaque. (*C.A.*)

PATENTS

Sheet-glass surfacing apparatus. JOHN L. DRAKE. U. S. 1,714,301, May 21, 1929. In sheet-glass surfacing apparatus, a plurality of glass surfacing units, means to move a sheet of glass progressively beneath the surfacing units, and means to prevent an appreciable change in the temperature of the glass sheet as it passes from one unit to another.

Sheet-glass surfacing apparatus. JOHN C. GIPE. U. S. 1,714,307, May 21, 1929. In a machine for mounting glass sheets which are to be surfaced, a bed upon which the glass is adapted to be mounted, a layer of plastic material on the bed and upon which the glass initially rests, means to move the bed in a horizontal path, and a plurality of pressing instrumentalities arranged with their pressing surfaces in an inclined plane and adapted to press the glass into the plastic material.

Annealing glassware. PERCY Q. WILLIAMS. U. S. 1,714,707, May 28, 1929. A glassware annealing leer comprising an annealing chamber, a ware conveyer, a heating unit at the forward end of the annealing chamber, means causing an annealing medium to pass through the heating unit into the annealing chamber, and means for exhausting the annealing medium from the annealing chamber and causing movement of the ex-

hausted medium forwardly of the leer in contact with the lower side of the ware conveyer.

Beveling glass. NORMAN H. KLAGES. U. S. 1,714,959, May 28, 1929. A process of beveling a glass sheet, which consists in causing a relative movement of the edge to be beveled in the direction of length thereof with respect to a relatively large annular grinding wheel having its axis inclined with respect to the direction of movement and having its face beveled back from its central portion toward its periphery, so that the wheel engages the glass on one side only of its center and cuts a bevel from one end of the sheet to the other, holding the sheet against vibration and also holding the wheel and sheet firmly against movement away from each other during the relative movement, and positively engaging the edge of the sheet next to the wheel with stop means along a part of the thickness of such edge, so as to position the sheet and hold it against movement toward the wheel, the movement of rotation of the cutting side of the wheel as it engages the glass edge having a component tending to move the sheet toward the stop means and also having a component tending to move the sheet in a direction opposite to the relative movement, and the entire bevel being cut at one pass.

Glass furnace. JULES J. QUERTINMONT. U. S. 1,715,568, June 4, 1929. A glass furnace for drawing continuous sheets of glass, comprising a drawing tank having a bottom, longitudinal and end walls and divided into a series of alternating drawing and reheating chambers, transverse partition walls resting on the bottom and separating the drawing and reheating chambers and provided with openings adjacent to the longitudinal walls to permit the body of molten glass in contact with and in proximity to the longitudinal walls to flow through the openings from the reheating chambers into the drawing chambers during the drawing of the sheets of glass.

Portable mitering machine. WILLIAM OWEN. U. S. 1,716,279, June 4, 1929. The combination with a table adapted to carry the sheet to be grooved or mitered, of a guide frame seated upon the sheet, means for clamping the guide frame to the table, a carriage mounted for guided movement along the frame, a motor and mitering wheel driven from the motor upon the carriage, means for adjusting the wheel up and down with respect to the sheet, and means operable from the end of the frame for moving the carriage back and forth.

Filling glass pots. WILLIAM OWEN. U. S. 1,716,280, June 4, 1929. Apparatus for filling glass pots in a furnace having a series of feed openings through its sides adjacent the pots, comprising a truck mounted for movement along the side of the furnace, a frame thereon having a pair of spaced bearings in substantially horizontal alignment, a substantially horizontal feed chute having its rear end journaled in the bearings and adapted to be moved through one of the openings to a position of discharge above a pot, a batch hopper carried by the truck and having its lower end directed into the rear end of the feed chute, feed means upon the interior of the chute effective by the rotation of the chute to feed the batch therethrough, a gear on the chute intermediate the bearings, and means for driving the gear.

Making plate glass. CHESTER E. HENDERSON. U. S. 1,716,312, June 4, 1929. The combination with a glass melting tank having an outlet, of a pair of driven rolls beneath such outlet inclined to the horizontal in position to receive therebetween the flow of glass from the outlet adjacent the roll ends which are elevated above the level of the other ends.

Glass mold. BLASIUS BART. U. S. 1,756,350, June 4, 1929. A mold having a convex central portion, an outstanding flange projecting horizontally from the perimeter of the convex portion and an upstanding rim outlining the flange, the rim provided with an overflow recess.

Glass furnace. THOMAS COURTNER MOORSHEAD. U. S. 1,716,456, June 11, 1929.

A glass furnace for use with bottle-forming machines of the suction type comprising a forehearth, a dam positioned in the vicinity of the point where the bottle-forming machine sucks its charge, a second dam positioned in front of the furnace and glass-circulating means positioned between the dams, the first dam also being adjacent the glass-circulating means.

Polishing glass. CHARLES HEUZE. U. S. 1,716,819, June 11, 1929. In apparatus for the continuous polishing of glass in which both the glass carrying tables and the polishing runners travel, a conveyer located above the polishing apparatus and adapted to convey the runners from the finish to the start of their operative course, a lifting device at the finishing end adapted to lift each runner off the tables and deposit it on the conveyer, a lifting device at the starting end adapted to lift each runner off the conveyer and deposit it over the tables and a felt cleaning device adapted to clean the felts of each runner during its travel on the conveyer.

Annealing furnace. WILLIAM M. HEPBURN AND ERNEST W. WEAVER. U. S. 1,716,956, June 11, 1929. A continuous annealing furnace comprising main and final heating chambers arranged end to end, a restricted work passage therebetween, a burner firing into the main chamber from its front end in a direction toward the final heating chamber, a preheating chamber opening on the main chamber, and waste-gas outlet in the preheating chamber through which the products of combustion from the main chamber must pass out of the main chamber, and means for heating the final heating chamber.

Drilling device for manufacture of glass-bottle necks. JULES ALEXIS BAYET. U. S. 1,717,304, June 11, 1929. A drill point whose surface is covered with adherent diamond dust, and which is provided with an axial conduit and with external grooves.

Feeding glass. WILLIAM J. MILLER. U. S. 1,717,802, June 18, 1929. (1) In feeding glass, the process of producing measured and shaped mold charges which consists in discharging a measured mass of glass through the discharge orifice of a tank or other container, introducing a measured quantity of liquid into a suitable forming receptacle which liquid is gasified by the heat to produce a cushion in the receptacle, catching the measured mass in the receptacle to impart thereto the desired contour and thereby complete the formation of the mold charge, discharging the completed mold charge from the receptacle, and severing the neck connecting the mold charge with the discharge orifice. (2) In feeding glass, for use in connection with a tank or other container provided with a discharge orifice, the combination of a gathering cup adapted to be positioned beneath the orifice to catch the glass and form gobs, fluid pressure means for alternately presenting the cup to the orifice and discharging its contents, means for shearing the necks of glass connecting the gobs to the orifice, fluid-pressure means for operating the shearing means, means coacting with the orifice to intermittently interrupt the travel of the glass therethrough, fluid pressure means for operating the last-mentioned means and a common control for all of the fluid-pressure means.

Glass rolling. NAAMLOOZE VENNOOTSCHAP MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Brit. 309,179, May 29, 1929. The making of glass plates by a double-roll machine in which the plates, as they are formed, are received on a conveyer by which they are carried into and through the leer is discussed. The plates are rolled at a high speed, and it is necessary to reduce their speed while on the conveyer unless a leer of abnormal length be used. According to the invention, the rolling machine is moved backward at a speed which is substantially equal to the difference between the high speed at which the plates are rolled and the low speed at which they are carried through the leer. The conveyer may consist of rollers or of an endless band or a traveling transporting table.

Glass rolling and annealing. NAAMLOOZE VENNOOTSCHAP MAATSCHAPPIJ TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Brit. 309,180, May 29, 1929. The making of glass plates in which charges of glass are rolled intermittently by a double-roll machine, and the plates so formed are received on a roller table which conveys them to a roller leer is discussed. The invention consists in driving the rollers of the table at the same speed as the leer rolls, and in moving the table toward the leer, while receiving a glass plate, at a speed which is equal to the difference between the high speed at which the plate is rolled and the low speed at which it is carried through the leer. When the table stops at the mouth of the leer, the glass plate passes onto the leer rollers without stopping or changing speed. In order that the plates may follow one another through the leer at close intervals, the leer rollers, during the time between the reception of one plate and the introduction of the next, are alternately rotated in opposite directions without changing their circumferential speed. A reciprocating movement is thus imparted to the plates in the leer, and the tail end of the plate which was last pushed into the leer is kept near the entrance until the succeeding plate is introduced. The leer may be provided with a fore chamber into which table enters, while a plate is still being rolled, in order to prevent the glass from cooling too rapidly before it enters the leer.

Composite sheets of glass and cellulose nitrate of cellulose acetate. J. J. ROWE. Brit. 298,888, June 22, 1927. A clear cellulose derivative varnish which may contain cellulose nitrate or acetate is applied to the glass and allowed to dry and the glass is then united by heat and pressure to a sheet of celluloid or like material. (*C.A.*)

Glass making. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOIT. VAN OCTROOIEN. Fr. 647,650, Jan. 24, 1928. Guides for sheet glass between the rollers, etc., are described. (*C.A.*)

Reënforced glass. PERCY H. HEAD AND SAFETY GLASS AND METAL PRODUCTS, LTD. Fr. 648,201, July 2, 1927. In making reënforced glass of several sheets cemented together, 2 or more of the sheets have a thickness which contrasts with the other sheets. Thus, 2 thin sheets are joined to one thick middle sheet. (*C.A.*)

Furnace for making plate glass. JEAN HENRI LEMAIRE. Fr. 648,225, Feb. 4, 1928. (*C.A.*)

Reënforced glass. JACQUES DUCLAUX. Fr. 648,990, July 1, 1927. Between 2 sheets of glass is placed a layer of cellulose, methyl- or ethyl-cellulose or caroubine. If celluloid is used a layer of a substance which will prevent access to the celluloid of light rays having a wave-length less than 0.00033 mm. is interposed. Such substances include stannates, molybdates, tungstates, colloid salts of Pb, Hg or Bi, benzophenone, aromatic hydrocarbons such as stilbine or dibenzyl. PrOH, iso-PrOH, BuOH, or AmOH is used instead of MeOH or EtOH in the baths into which the celluloid is passed. (*C.A.*)

Glass furnace with movable hearth. MARCEL FOURMENT AND JEAN J. LADURÉE. Fr. 648,993, July 1, 1927. (*C.A.*)

Colored glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIM. DE SAINT-GOBAIN, CHAUNY ET CIREY. Fr. 648,999, July 2, 1927. Violet-colored glass is made by adding TiO_2 to glass having a base of phosphoric oxide, or of oxides of P and B, SiO_2 being absent. The color is deeper if C or a C compound is added. A light filter with a nearly constant transparency for all the visible rays is made by combining a violet glass as above with a silicate glass colored green by oxide of Fe. (*C.A.*)

Porcelain and glass. DEUTSCHE GOLD-UND SILBER-SCHEIDEANSTALT VORM. ROESSLER. Fr. 649,666, Feb. 24, 1928. Combinations of porcelain and glass are made by fusing together glass, the coefficient of expansion of which does not pass about 5.10^{-6} and the softening point of which is the same as that of the porcelain glazing, and a

porcelain, the coefficient of expansion of which is as high as possible. Silicate or borate glasses such as those called "Pyrox" and "Supremax" are particularly suitable. (*C.A.*)

Apparatus for supplying molten glass. DEUTSCHER VERBAND DER FLASCHEN-FABRIKEN G.M.B.H. Ger. 472,140, Aug. 24, 1924. (*C.A*)

Surfaces for working plastic glass. SENDLINGER OPTISCHE GLASWERKE G.M.B.H. Ger. 472,141, July 10, 1925. Surfaces such as chamotte plates on which glass is to be worked while soft are coated with H_2WO_4 or H_2SnO_3, or compounds thereof such as $CaWO_4$, to prevent adhesion of the glass. (*C.A.*)

Annealing sheet glass in tunnel leers. EMPIRE MACHINE CO. Ger. 472,142, March 11, 1924. Gases are supplied to the tunnel above and below the glass level and the temperatures of the streams are adjusted so as to obtain uniform cooling on both faces of the sheet. (*C.A.*)

Hollow bodies from quartz glass. FRITZ ECKERT. Ger. 472,143, April 22, 1927. In making hollow bodies from quartz glass by melting powdered quartz on to a quartz glass hollow body, a cooling agent is led through the hollow body during the melting. (*C.A.*)

Designs on sheet glass. EDWARD DANNER. Ger. 472,314, June 21, 1925. A stream of glass is guided on to an impression roller provided with designs and while plastic is forced into contact therewith by gas pressure. (*C.A.*)

Electric glass-melting furnace. AKTIESELSKAPET RAEDERS ELEKTROGLASOVEN. Ger. 472,780, Sept. 19, 1925. Details of construction are given. (*C.A.*)

Furnace with cooling canals for table glass. PILKINGTON BROS., LTD. Ger. 472,781, Nov. 13, 1924. Details of arrangement. (*C.A.*)

Glass. GLASFABRIK A.-G. (Gerhard Stein, inventor). Ger 473,458, June 26, 1925. Molds or molding tools for use with glass in a thermoplastic state are prepared from a relatively soft material, *e.g.*, soft Fe, and are then coated on the working surface with Cr. Molds with sharply defined patterns can be so obtained. (*C.A.*)

Device for rolling glass sheets into cylinders. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOIT. VAN OCTROOIEN. Ger. 474,754, Mar. 16, 1927. (*C.A.*)

Device for conveying glass plates to the annealing furnace. NAAMLOOZE VENOOTSCHAP MIJ. TOT BEHEER EN EXPLOIT. VAN OCTROOIEN. Ger. 474,755, May 31, 1927. (*C.A.*)

Device for conveying glass plates to the annealing furnaces. NAAMLOOZE VENNOOTSCHAP MIJ. TOT. BEHEER EN EXPLOIT. VAN OCTROOIEN. Ger. 474,755, May 31, 1927. (*C.A.*)

Silvering glass. CARL GRAMBACH. Swiss 129,233, Jan. 14, 1928. Plate glass is silvered by first coating it with a layer of liquid enamel, drying, and coating with a layer of readily fusible metal. (*C.A.*)

Heavy Clay Products

Masonry engineering. F. T. HEATH. *Brick Clay Rec.*, **74** [12], 810–12 (1929).—The real missing link in construction engineering line-up is "masonry engineering," a profession which will devote time and thought to an unprejudiced study of masonry units. E.J.V.

Raw materials in manufacture of paving brick. J. B. MONNIER. *La Céramique*, **31** [486], 245–49 (1928).—M. points out that paving brick are used in large numbers in Holland and the U.S. and could be utilized to a much greater extent in France. As they are heavy and inexpensive they must be manufactured near their market. The usual method of manufacture from hard shales, having a firing range of 120°C and an analysis: silica 65%, alumina 21%, iron oxide 7%, lime and magnesia 1%, and alkalis 3.5

to 6.5%, in periodic downdraft kilns is described. In order to manufacture paving brick near their market in France, it is necessary to utilize common brick clays with short firing ranges and analyses such as: silica 74.2%, alumina 9.6, iron oxide 6.2, lime 8.3, and magnesia 0.4. A procedure is described which is being used by M. to good advantage with common clays. This involves tempering, power pressing, drying and firing in a car tunnel kiln, and using powdered coal as fuel. The brick are set on refractory shapes so they do not deform readily. By a suitable cooling process, a network of fine crystals of pyroxene, angite, and sometimes wollastonite is developed. This incloses crystals of quartz which offer great resistance to wear. The fuel consumption is about 120 kg. per T. as compared with 180 to 250 kg. per T. in periodic kilns. Ninety per cent of the brick are first grade. These "artificial pavers" have the following properties: density, 2.150 to 2.300; compressive strength, 1600 to 2400 kgs. per sq. cm.; impact resistance, a 4.5 kg. weight dropping from the height of 1 m. causes complete failure in 50 to 70 blows; rattler test, 15.4% loss in weight after 1800 revolutions. A discussion follows.

A.E.R.W.

Barium as preventive of efflorescence. L. P. COLLIN. *Brick Clay Rec.*, **74** [11], 730–32 (1929).—The most effective preventive agent and the one most commonly employed is barium carbonate. The use of barium carbonate as a preventive is dealt with. The mixing of this material is important since barium carbonate is practically insoluble and in order to obtain results it is necessary to secure a thorough mixture of the barium grains throughout the clay body. Various methods are discussed. E.J.V.

Efflorescence in brickwork. W. A. WRIGHT. *Ceram. Age*, **12** [4], 139–41 (1928).—(Presented at Natl. Assn. Clayworks Managers, Lincolnshire Branch; from *Claycraft.*) W. points out the importance of efflorescence and the fact that the builder and architect place the responsibility on the brickmaker. Efflorescence is described as the white frosty appearance which occurs after bricks have been placed in a building, whereas kiln white is the white scum sometimes seen on bricks as they are withdrawn from the kilns. Efflorescence is due to the formation of a close carpet of countless minute colorless crystalline stalks composed largely of magnesium sulphate with calcium hydroxide or free lime. The deposit is formed by leaching from the brick or mortar and subsequent recrystallization. The deposit is heaviest at the point of greatest evaporation. When the jointing alone is at fault the zones of greatest crystallization are found in its neighborhood, streaks of salt running parallel with the edges of the brick. Where the bricks are at fault, crystallization covers the whole face of a brick and may be most prominent in regions farthest from the jointing. The latter appearance is sometimes due to faulty mortar if the bricks are porous. Vitrified brick would not produce efflorescence. Gypsum in mortar is sometimes the cause of efflorescence for which there is no real remedy. Ashes yield sodium salts and are, therefore, undesirable mortar constituents. Many brands of Portland cement contain 3 or 4% of gypsum, added as a modifier, and for this reason, sand-cement mortars are often bad offenders. W. recommends systematic chemical analyses of both brick and mortar in order to avoid efflorescence. Since the use of washed clay is too expensive, clays containing soluble salts are commonly treated with barium carbonate, which should be added in the mixing pan or in the mixer as a water-barium carbonate cream or mixed with ground bricks. In the discussion by Russell, Searle, Thrupp, Presswood, Clarke, Hemingway, Cobbam, Stalter, and Sayer, various causes and methods of prevention of efflorescence are outlined.

A.E.R.W.

New type of tile. TONY ROTA. *Brick Clay Rec.*, **74** [12], 799 (1929).—A new type of tile for construction of walls and partitions by using 2 x 4 studding in combination with the tile has been invented. This method provides space for the nailing of strips on the inside of the walls and also provides a combination of tile and studding to guaran-

tee against walls cracking and crumbling during earthquake disorders; it is further claimed to eliminate the necessity of wire for stucco. It may be made in any size of clay or cement. E.J.V.

Fire-resistance tests of building materials and constructions. ANON. Bur. Stand., *Tech. News Bull.*, No. 145, pp. 41–42 (1929).—An account is given of the fire-resistance activities of the Bureau as presented before the Washington meeting of the Amer. Inst. of Refrigeration. The Bureau work has dealt mainly with the fire-resistance properties of materials and members entering into the construction of buildings, the fire hazard of building contents, the severity of fires that can result with given amounts of combustible building contents and the protection afforded by devices such as insulated record containers. R.A.H.

Kellastone nailing base tile. ANON. *Arch. & Bldg.*, **61** [4], 130 (1929).—As an aid in partition construction, a new nailing base tile is on the market, which has particular advantages for the construction of fireproof partitions on top of concrete floors. The tile is of magnesite and is nailable. It eliminates wood grounds for plastering and has a load-bearing strength in excess of 5 T. per lineal foot. Further, it is fire, rot, and vermin proof, and reduces the cost of construction. It is manufactured in 30-in. lengths for use with partitions built of clay, or gypsum partition tiles of standard sizes and is set in the same mortar as is used for such tile. Because of the nature of its design, the tile automatically centers the partition tile and provides grounds for plastering. In finishing, wood, or metal base can be nailed or screwed direct to the tile. E.P.R.

Vitrified brick pavement construction. GEORGE F. SCHLESINGER. *Clay-Worker*, **91** [6], 481–83 (1929).—A review of the use of paving brick and the advance in brick pavement construction, in regard to cushion and base, depth of brick course, filler, type of brick, and simplification of sizes is discussed. E.J.V.

Clay products for airports. G. K. SPENCER. *Brick Clay Rec.*, **74** [12], 804–806 (1929).—According to S., building brick, structural clay tile, drain tile, and paving brick have tremendous opportunities for the sale of their products in airport construction. These materials are the favorites in the building of airports and this business is sure to increase tremendously in importance and volume. It has been estimated that the dollar volume of construction in connection with airports has reached an annual total of $300,000,000. E.J.V.

Factory design and equipment. XXIII. T. W. GARVE. *Clay-Worker*, **91** [6], 484–87 (1929).—This is the last of a series of articles on this subject. General plant problems for the designing engineer, such as the raw materials, clay supply, grinding department, machine room, power, handling of the ware, labor, general preliminary layouts, structural problems, other supplies, plant balance, etc., are discussed. For XXII see *Ceram. Abs.*, **8** [7], 502 (1929). E.J.V.

Obsolescence. ANON. *Clay-Worker*, **91** [7], 577 (1929); for abstract see *Ceram. Abs.*, **8** [6], 457 (1929). E.J.V.

Pacific Coast uniform code. NORMAN W. KELCH. *Brick Clay Rec.*, **74** [11], 735 (1929).—A statement by the secretary-manager of the Clay Products Institute of Calif. which outlines its position in regard to building codes. A table on rated fire resistance periods of various competing materials which appears in the code and which does not appear to be fair or equitable as far as clay products are concerned is reprinted. E.J.V.

Wisconsin modernizes its plants. ANON. *Brick Clay Rec.*, **74** [12], 796–98 (1929).—The Wisconsin clay plants are undergoing notable changes in mechanical efficiency which point toward making a better product. E.J.V.

Anti-friction clay products. ANON. *Clay-Worker*, **91** [7], 565–76 (1929).—The Bessemer plant of the Metropolitan Paving Brick Co., which is ideal in its arrangement,

flow of material, and economy through mechanical control is described in detail. In complete operation, this plant produces 150,000 ten-pound paving block or 80,000 block and 130,000 face brick, as the schedule may be. The kiln is probably the largest continuous kiln in the world, being a 208-chamber Haigh kiln, over 3500 ft. long, and shaped like a horseshoe. E.J.V.

Effect of standard costs. ANON. *Brit. Clayworker*, **38** [445], 44–45 (1929).—Modern costing practice is now developing tendencies which are important to all concerned in works management and production. This new system is known as "standard costing" and is based on a comparison of actual costs against standard or predetermined costs. Standard costs fulfill two separate and distinct functions: (1) they can be confidently accepted as trustworthy information for the purpose of price fixing and tendering and (2) they render the necessary particulars for computing the value of production or services earned. The expenses or costs are divided into a series of groups and may be based on output "per 1000 bricks" or each order may be considered as a separate basis. Striking discrepancies are often revealed in the comparison of costs for different periods. The article describes definite examples and shows the advantage of "costing," and how much more beneficial it is than "orthodox costing." R.A.H.

Plant efficiency. ANON. *Brick Clay Rec.*, **74** [13], 862–66 (1929).—A description of Zerrenner Bros., New London, Wis., is given. This small plant is an economical producing unit since it has been modernized. After replacing scove with downdraft kilns, the Boss system of firing, electrified plant, waste heat driers, wire-rope system of pallet conveying, power shovel for digging, and several other interesting devices cut production costs. E.J.V.

Brooklyn Brick Co. ANON. *Clay-Worker*, **91** [6], 488–90 (1929).—A description of the plant of this company at Brooklyn, Ind., where 6 distinct types of face brick are produced, *i.e.:* (1) Venetians, in multi-colors, indented texture, (2) Moss Rose, a rug texture in multi-colors, (3) Walnut Bark, an exact reproduction of walnut bark, (4) Old Manse, a sanded slightly irregular brick in red, brown, bluish black and gray, (5) Colonial Red Hearts, smooth sanded, and (6) Monastery, a smooth sanded brick in reds and browns to almost black. Over 19,000,000 of these brick were sold by the 14-kiln plant in 1928. E.J.V.

Hydraulic-Press Brick Co.. ANON. *Brick Clay Rec.*, **74** [13], 868–73 (1929).—This plant located at Crawfordsville, Ind., produces about 150,000 face brick daily when operating to full capacity. A shale described as an old sea deposit of the Paleozoic era is being used. The method of preparation is described. Kilns of the improved Eudaley type, having capacities of 160,000 to 175,000 brick are used, the ware being fired from 1800 to 1900°F for a period of $4^1/_2$ to 5 days. The plant is electrically driven throughout by a 440-volt 3-phase current. E.J.V.

BOOK

Manufacture of Hollow Brick and Tile. V. PINKL. Wilhelm Knapp, Halle (Saale), Germany. Price 4 marks.—The book describes in detail the manufacturing process by which hollow building materials are produced; such subjects as raw material, preparation of raw material and forming of ware, handling of green ware, drying, setting, firing, drawing, and loading. A final chapter is devoted to the use of these products. Illustrated. Reviewed in *Brick Clay Rec.*, **74** [12], 812 (1929); *Clay-Worker*, **91** [7], 585 (1929). E.J.V.

PATENTS

Brick-engobing machine. LORENZO M. MUMFORD AND ROY F. MILLER. U. S. 1,714,186, May 21, 1929. Apparatus for engobing brick, comprising means to produce and extrude a clay bar, a casing through which the bar is continuously moved, a source

of engobing material connected to the casing, and fluid pressure operated means to force the engobing material into the casing and against the clay bar.

Brick-die front. CHARLES E. NORTON. U. S. 1,715,859, June 4, 1929. A column forming die provided with an aperture for the discharge of a column of plastic material therethrough, the die having flexible portions for engaging the plastic column, and means for flexing the flexible portions, to produce a column of desired cross-section.

Automatic pallet-feeding machine. WILLIAM W. WALLACE. U. S. 1,716,349, June 4, 1929. An improved magazine for brick pallets and means for attaching the same to a brick machine, comprising a bottomless container, a plurality of reciprocatory fingers mounted at the bottom thereof, means for pivotally and adjustably mounting the bottomless container on a brick machine, and means connecting the bottom of the container with the brick machine for adjusting the magazine above a horizontal axis and with respect to the brick machine.

Refractories

A coke-fired gas producer for the ceramic industry. H. C. BARRETT. *Jour. Amer. Ceram. Soc.*, **12** [7], 435–42 (1929).—The initial installation of a coke-fired gas producer for manufacturing gas for firing silica brick in the United States is described in detail. The advantages of cold clean gas over dirty gas are pointed out with clarity. The features of the automatic operation are set forth showing that a better grade of constant volume and pressure gas can be produced. Operating data of a plant on million cubic-foot basis gives the power, coke, and water consumption.

Use of a small cupola in testing cupola refractories. JAMES T. MACKENZIE. *Jour. Amer. Ceram. Soc.*, **12** [7], 443–46 (1929).—A small cupola is lined on one side with the refractory under test and on the other side with one whose service record is known. A highly oxidizing melt is run, followed by thorough scouring with fluxes. The difference in resistance between the two materials gives a fairly accurate test on the usefulness of the one under test. Three typical tests are given in detail with the corresponding corroborative service records.

Optical methods as an aid to the study of refractories. T. N. MCVAY. *Jour. Amer. Ceram. Soc.*, **12** [7], 455–56 (1929).—The application of the petrographic microscope as an aid to the study of designating impurities in raw materials has proved successful. By the same methods fired refractories may be classified and the effects of bonds tested. Optical tests should chiefly be used to supplement and not to displace other methods of examinations.

Present status of tests for refractories. STUART M. PHELPS AND J. SPOTTS MCDOWELL. *Blast Fur. Steel Plant*, **17** [6], 910–17 (1929).—The problem of applying suitable tests to refractory materials involves a broad knowledge both of the materials and of the ends they are to serve. Tests for refractories may be divided into three general types: durability, suitability, and control. Durability tests can be made only in industrial furnaces, under actual operating conditions. Suitability tests may be carried out in the laboratory, under conditions which simulate those of service as closely as possible. Control tests, for maintenance of uniformity of product, should be relatively simple and require only a short length of time to perform. The P.C.E. gives an index of refractoriness, but is not a measure of the actual temperature which a material will withstand under long continued heating. The standard load test is not an index of refractories, but is a good control test, especially for brick to be used under load at high temperatures. Difficulties of interpretation affect the value of reheat and spalling tests. The most useful specifications are those of the control type. The object of the reheat test is to determine the constancy of volume of brick at a temperature higher than that at which they were fired. In the standard method they are heated in $4^1/_2$ hrs. to 1400°C, and maintained at that temperature for 5 hrs.

From measurements taken before and after testing, the percentage of linear change is calculated. Recent studies have shown that many brick of high refractory value exhibit in the reheat test expansion phenomena similar to those of overfiring. The cause of this so-called "secondary expansion" is obscure. It renders difficult the interpretation of reheat test data, for one cannot always be sure whether an abnormally high expansion results from overfiring, and is therefore an indication of inferior quality, or whether it is merely a "secondary expansion" which has no significance in service. A brick which shrinks, however, in the test will probably do so in service. F.P.H.

Refractory specifications and their use. J. D. RAMSEY. *Blast Fur. Steel Plant*, **17** [6], 905 (1929).—Inasmuch as the service required of refractories is so varied, a manufacturer should know the conditions under which his product will be used. F.P.H.

Thermal expansion of brick for insulating purposes. ANON. Bur. Stand., *Tech. News Bull.*, No. 145, pp. 40–41 (1929).—Recently it was found desirable in connection with one of the Bureau studies to determine the thermal expansion of brick used for insulating purposes. Expansion determinations from 20 to 1000°C were made on 3 brands of brick which were immediately available. The results are given and for comparative purposes expansion data obtained on a good grade of fireclay brick are included. The curves obtained from data determined on specimens cut from brick of Brands B and C are not greatly unlike those obtained on certain brands of fireclay brick. The expansion of the specimen cut from Brand A was unusually high, the total expansion at 1000°C (1832°F) being approximately $2^1/_2$ times as great as that of the other two brands. For comparative purposes the average coefficient of expansion obtained between (*a*) 20 and 200°C, (*b*) 200 and 600°C, and (*c*) 20 and 1000°C are given for the 4 different specimens, together with (*d*) the total expansion at 1000°C. The values given for the coefficient of expansion per degree centigrade must be multiplied by 10^{-6}, the values for total expansion are expressed in percentage of unit length. For Brand "A," the value for (*a*) is 44.2, the value for (*b*) 28.9, for (*c*) 13.6, and for (*d*) 1.325. In the case of Brand "B" the values are (*a*) 18.5, (*b*) 3.6, (*c*) 5.7, and (*d*) 0.55. For Brand "C" the values are (*a*) 9.7, (*b*) 4.9, (*c*) 5.7, and (*d*) 0.55. The data obtained on the fireclay brick for the same ranges in temperature are as follows: (*a*) 10.8, (*b*) 3.9, (*c*) 5.5, and (*d*) 0.53. R.A.H.

Modern chemical and petrographic laboratory for research and control work. GEORGE M. EARNSHAW. *Rock Prod.*, **32** [11], 61–63 (1929).—A description is given of the laboratory of the General Refractories Co. at Baltimore, Md. F.P.H.

Softening of refractories by heat. ANON. *Brick Clay Rec.*, **74** [13], 880–82(1929).—A technical bulletin has been issued by the Crescent Refractories Co., Curwensville, Pa., which treats in an elementary way the P.C.E. or the softening of refractories by heat. Although most of the material is of a rudimentary nature, it may serve as a review of essential facts in ceramic engineering and throw light on some points which were never explained as clearly as herein. See also *Ceram. Abs.*, **7** [3], 169 (1928). E.J.V.

Refractories research. W. F. BOERICKE. *Min. and Met.*, **10** [265], 16–18 (1929); *Refrac. Jour.*, **4** [44], 261 (1929); for abstract see *Ceram. Abs.*, **8** [3], 193 (1929).

Failures in refractory materials. H. WEIGHTMAN. *Power*, pp. 624–27 (1928); *Refrac. Jour.*, **4** [44], 261 (1929).—The causes of failures in refractories are discussed and illustrated by photographs. Failures are due to any of the following causes: (1) overloading, (2) defective furnace design, and (3) stresses during operating. E.P.R.

Characteristics of refractories. J. F. HYSLOP. *World Power*, **10**, 253 (1928); *Refrac. Jour.*, **4** [44], 261 (1929); for abstract see *Ceram. Abs.*, **8** [4], 279 (1929).

Lugged brick for refractory linings. ANON. *Cement, Mill & Quarry*, **34** [6], 62 (1929); *Refrac. Jour.*, **4** [44], 262 (1929).—A new method of building refractory linings, calling for the use of lugged refractory brick, has been introduced by the Covell Corp. (Philadelphia). The lugs provide openings in the brick which are filled with refractory joint material by a cement gun. This method, called Co-Weld-Cor, reverses the old tradition that "the thinner the joints the better the wall." The bonding material, as blown into the joints, is very dense, stronger than the brick itself. E.P.R.

Kaolinic refractories. ANON. *Heat Treatment Jour.*, pp. 50–60 (1929); *Refrac. Jour.*, **4** [44], 261 (1929).—The properties of kaolinic refractories are discussed and their applications outlined. A new method of manufacture is proposed, a high grade product being obtained exhibiting no permanent volume change and but slight shrinkage at 3000°F. E.P.R.

Magnesite brick. ANON. *Refrac. Jour.*, **4** [44], 259 (1929).—Magnesite brick contain 80 to 90% of magnesia and 4 to 8% of iron oxide. The percentage of magnesia in different brick varies from 83 to 96%. The matter insoluble in acid does not exceed 3% and in most brick was negligibly small. The silica varies from 0.8 to 5.1, alumina from 0.2 to 2.2, iron oxide 0.2 to 8.6, manganese oxide 0.0 to 1.4, and lime 0.4 to 2.7 per cent. The water-absorption varies from zero to over 12%, the porosity from 15 to 28%, the specific gravity from 3.54 to 3.65%, and the volume weight from 2.18 to 3.47%. The softening point under a pressure of one atmosphere commenced at 1350 to 1790°C collapse occurring at 1390 to 1700°C, and the range of softening extended from 40 to 320°C. The maximum expansion at 1300°C was 0.5 to 2.17%; the increase in length after being fired four times at cone 17 was 0.03 to 0.1%, but some brick shrank 3.2% under the same conditions. An abrasion test showed that the weight of material removed varied from 0.3 to 3.68 g. per sq. cm. The crushing strength when cold was 88 to 860 T. per sq. ft., and that at 1200°C, 85 to 560 T. per sq. ft. Such great variations make specifications difficult because some of the figures relate to odd brick and are not applicable to large numbers. The ordinary test for refractoriness is of small value in comparing magnesite brick, but the refractoriness under a pressure of one atmosphere is valuable. Under this test, only the poorest magnesia brick show any signs of collapse under 1500°C, and the better ones remain unaltered to 1800°C. Most magnesia brick collapse somewhat suddenly when the critical temperature is reached, though brick of poor quality have a softening range of about 300°C; and the better brick, about 50°. The effect of any iron oxide present in the brick is most noticeable in the way it produces a rounding of the curve in a "refractoriness-under-small-load" test, though other fluxes may have a similar effect, one brick containing 95.4% of magnesia and only 1% of iron oxide showing as much "rounding" as another brick with more than 7% of iron oxide. The presence of both silica and iron oxide is objectionable, as they have a greater fluxing action than either substance separately. The best brick contains 5.7% of iron oxide and a very small percentage of silica. If a purer magnesite is used, it must be fused electrically and care taken to secure the maximum density by careful attention to details during the manufacture of the brick as well as by firing them at a very high temperature. A microscopic examination of thin slices of magnesite brick does not always show marked differences between them. While some brick produce typical micrographic specimens, others give uncertain indications. The X-ray spectrum of magnesite brick shows that some periclase is present even in lightly-fired caustic magnesia, though it is the chief constituent in magnesia which has been electrically fused. Poor magnesite brick show spectral lines not present in good brick. The fact that caustic, sintered, and fused magnesia all give the same X-ray spectrum is significant, because it shows that prolonged heating does not bring about any unexpected change in the material; it only increases the proportion of periclase (crystalline magnesia) present. E.P.R.

Silica as a refractory in the steel plant. ROBERT B. SOSMAN. *Blast Fur. Steel Plant*, **17** [6], 920–24 (1929).—After stating the action of the three forms of silica when subjected to heat, S. comments on the effect produced by combining silica with other oxides. The melting-points of tridymite and cristobalite are unfortunately just at, or a little below, the most effective operating temperature of the open-hearth furnace. The temperatures obtainable with gas or tar flames can easily be carried to 1800 or 1900°C. But 1713°C is the absolute deadline for the silica roof. Nothing can be done about this lamination, because as a general rule the addition of anything to a pure substance lowers the temperature at which it will liquefy. Only if there is solid solution with a substance of high melting-point and even then only if the melting-point curve has the form of a continuously rising curve joining the lower to the higher melting-point is there any possibility of raising the melting-point of the substance by adding small amounts of something else to it. Now solid solutions of other substances with silica are almost unknown. The usual relationship is the formation of a eutectic of lower melting-point. Therefore, it appears that there is nothing to be gained in the direction of higher temperatures by the addition of other substances to pure silica. F.P.H.

Properties of and specifications for silica brick for coke ovens. H. KNUTH-BONN. *Feuerfest*, **5**, 21–26 (1929); *Refrac. Jour.*, **4** [44], 260 (1929); for abstract see *Ceram. Abs.*, **8** [7], 507 (1929).

Mortar for coke ovens. P. B. ROBINSON. *Feuerfest*, **5**, 13–15 (1929); *Refrac. Jour.*, **4** [44], 260 (1929); see *Ceram. Abs.*, **8** [7], 507 (1929).

Cupola repairs and maintenance. B. P. *Mech. World*, **85** [2211], 458–59 (1929).—The firebrick lining of a cupola is destroyed in time by the action of the heat and alkaline substances in the fuel, and also the grinding of the iron and fuel charges as they work down from the charging door. A strong blast on a nearly empty cupola, or through a badly laid charge, shortens the life of the lining, which is greatly increased by proper cleaning, picking out, and daubing after each blow is required. The author discusses most economical refractory construction, method of repairing, and refractories best suited. E.P.R.

Checker work for chambers of regenerators. W. TAFEL. *Stahl und Eisen*, **49**, 355–56 (1929); *Refrac. Jour.*, **4** [44], 260 (1929).—Various arrangements of packing regenerator chambers are shown. Two methods are shown in which the riser bricks are set at an angle of 45° instead of vertically, a horizontal course being laid on each course of sloping bricks. By this arrangement a gain of some 20% in heating surface is secured. The ordinary ratio, heating surface to weight, is 25.1 sq. m. per T., but with sloping brick the ratio may be increased to 31.7 or even to 37.2, according to the thickness of brick employed. This advantage is counter-balanced by certain drawbacks and no particular economy is secured by the use of sloping brick. Neither is there any advantage in the use of Moll-Rhenania brick, which is curved, so that when courses of such brick are built into a regenerator they give a passage of elliptical form alternating with one of 4 sides all of which are convex. A curved brick stores and gives up no more heat than a flat one. E.P.R.

Blended clays for use in sagger batches. C. C. ENGLE. *Ceram. Ind.*, **12** [6], 658–59 (1929).—Unquestionably, clays high in alumina will produce high quality grog. The use of kaolins in saggers not only improves their ability to stand repeated firings better but will benefit the resulting grog obtained. These kaolins perform beneffcial functions which E. has not seen discussed, namely, that of raising the softening point of other clays used with them and also absorbing impurities if present in other clays. The degree to which the benefits of these functions can be realized depends upon the intimacy of mixing in the preparation of the clays. If kaolin is to be used it should

be in a form readily assimilated by the sagger mix. Kaolins, therefore, ought to be ground. F.P.H.

Art of masonry in the steel plant. ROBERT SMITH. *Blast Fur. Steel Plant*, **17** [6], 906–907 (1929).—A practical master mason tells in his own way the story of laying brick for best results. Many good points are given covering important details. F.P.H.

Theory and application of regenerative principles in the steel industry. T. J. MCLOUGHLIN. *Blast Fur. Steel Plant*, **17** [6], 852–56 (1929).—A review of the principles of heat recovery through regeneration in the various heating equipment in steel plants is discussed with reference to checker construction and operation. F.P.H.

Steel castings heat treated in electric furnaces. A. W. LORENZ. *Fuels and Fur.*, **6** [7], 923 (1928).—A heat-treating unit consisting of 4 box-type electric furnaces equipped with a unique charging machine and 1 car-type furnace, with a total capacity of 500 T. per month, used in the heat treatment of miscellaneous steel castings is described. A.E.R.W.

Refractory materials in gas industry. H. CASSAN. *La Céramique*, **31** [486], 249–52 (1928).—C. describes the rapid growth of the gas industry and its importance as a consumer of refractories. The constantly increasing temperatures used in gas retorts have made refractory problems difficult. To provide gas-tight retorts, refractories without shrinkage are necessary, hence the tendency to use silica. The difficulties due to the expansion of silica are described. The importance of porosity and permeability is pointed out. Carbon deposits in very porous and permeable bricks decrease their permeability and increase their thermal conductivity. Silica cements are discussed. A.E.R.W.

Measuring thermal conductivity of insulating and refractory materials. M. L. HARTMANN, O. B. WESTMONT, AND C. E. WEINLAND. *Ceram. Age*, **12** [6], 225–33 (1928); for abstract see *Ceram. Abs.*, **8** [5], 341 (1929). A.E.R.W.

Properties of refractory clays for the glass industry. G. GEHLHOFF, H. KALSING, K. LITZOW, AND M. THOMAS. *Glastech. Ber.*, **6** [9], 489–531 (1928).—A detailed investigation of the properties of refractory clays for the glass industry is presented. The tests (Glass Technology Laboratory of Osram Co., Weisswasser) were made on 16 well-known German clay deposits of various kinds, with amounts of alumina ranging from 19 to 48%, in some Bohemian clays of importance to Germany, two kaolins, natural sillimanite and corundum. Besides the usual ceramic methods for testing ((1) chemical, rational, and elutriative analysis, (2) measurement of drying and firing shrinkage, (3) determination of the amount of water for wetting up, (4) bending strength in the leather-hard state, (5) Seger-cone melting temperature, and softening under load test) new methods of a physical type have been evolved to determine the adaptability of clay for the glass industry. Thus clays were tested for resistance to molten soda ash, salt-cake, boric acid, and lead oxide; resistance to molten batches of various kinds, and to moving the quiescent glass. In addition the thermal resistance was determined by laboratory methods. The different performances of clays with regard to the tests are described, as also is the effect of the porosity and grain size of the grog employed on the particular properties. In order to find the effect of the accessory constituents of clay, alkalis, and iron oxide, systematically varying mixtures with artificial additions of these constituents were tested. The tests showed that the most important properties of the glass industry, *i.e.*, refractoriness and capability to resist molten glass are chiefly dependent on the porosity and the composition of the clay. Materials of greater porosity are not very refractory and have little resistance against molten batches. Clays high in alumina show more resistance than highly siliceous clays; the latter are, however, more resistant when salt-cake is used. The experiments with clay mixtures

prove that there is no point in trying to improve an inferior or unsuitable clay by means of higher grade material; in many cases the reverse occurred. Rules of general application, however, could not be advanced. E.J.V.

Expansion and tensile strength of refractory materials for the glass industry. J. F. HYSLOP, R. F. PROKTOR, AND N. C. BIGGS. *Glastech. Ber.*, **6** [10], 561–71 (1929).—This investigation was made to classify refractory materials for the glass industry and to single out important properties that are strongly influenced by changes in the method of manufacture and the heat treatment. The tests include expansion figures at temperatures up to more than 1400°C and data as to the strength of the material over the same range of temperature. Determination of expansion was made on samples taken from pots, tank blocks, special shapes, furnace brick, and synthetic silicates. The results classify these refractories into three groups. Each of these groups is based on a characteristic, well-defined expansion curve above 1000°C. (1) Near or slightly above 1000° a rapid and considerable amount of shrinkage is noticed (indication of slightly or moderately fired material, quartz or cristobalite effect is present or absent). (2) Above 1000° a slow or sudden decrease in the expansion figure takes place (indication of a sharply fired material; quartz effect not present, cristobalite effect may occur). (3) The curve runs practically in a straight line, increasing steadily up to 1400° (indication of strongly fired material, consisting of sillimanite or synthetic silica-alumina mixtures). Materials belonging to group (1) have high porosity, small resistance against sudden changes in temperature, and small resistance against the corrosive action of melted glass and flue dust. At higher temperatures cracks are apt to occur. Products belonging to group (2) are mechanically stronger and more stable at high temperatures. The sensitivity against sudden changes in temperature depends on the amounts of cristobalite and the quantity of glassy material present. Products of group (3) are usually very dense and have a high percentage of alumina. They are in a class by themselves, being special materials for the highest demands. Determinations of the tensile strength were made primarily to determine the strength at high temperatures and to ascertain the bonding power between grog and fire clay. To carry out the experiments the temperature was increased until the breaking point was reached under a load of constant weight (500 g. per sq. cm.). The expansion of the test weight was also measured. It was found that the composition (alumina content), the degree of firing of the test piece and the grog, and the grain size of the latter have an important bearing on the tensile strength of refractories at high temperatures. Unsatisfactory results with refractories high in alumina are caused by insufficient heating. With poorly fired or moderately fired products high in silica better results can sometimes be obtained than with poorly fired refractories high in alumina. The best results are obtained from adequately fired materials, high in alumina. The measurement of the tensile strength at high temperatures is one of the best methods to judge the value of a refractory for practical purposes, and gives information regarding service behavior of glasshouse refractories toward the corroding and disintegrating properties of batch and molten glass. The work done is preliminary to a comprehensive research, but the tests indicate that material which shows little expansion under load, and a high temperature before breaking, is likely to perform well in a glass tank, because it suggests a high degree of cohesion between grog and clay. In general, highly fired materials have a low porosity. E.J.V.

Commercial manufacture of carborundum, elektrokorund, and elektroschmelzzement. SCHNEIDLER. *Metallbörse*, **18**, 708 (1928).—Elektrokorund is crystalline Al_2O_3; elektroschmelzzement consists mainly of CaO and Al, instead of silicates like Portland cement. (*C.A.*)

The petrography of some magnesite brick. C. W. CARSTENS AND KR. KRISTOF-

FERSEN. *Norsk Geol. Tids.*, **10**, 1–13 (1928).—The article records results of chemical analysis of magnesite brick from 3 different localities, one being Austria. Compression tests at different temperatures up to 1730° are discussed. Experiments on some of the minerals used in making magnesite brick gave the following results: On heating to its melting-point (1500°) serpentine ($H_4Mg_3Si_2O_9$) gives $Mg_2SiO_4 + MgSiO_3 + H_2O$. Talc ($H_2Mg_3SiO_4O_{12}$) heated to 1500–1550° gives $3MgSiO_3 + SiO_2 + H_2O$. Enstatite ($MgSiO_3$) heated with MgO gives Mg_2SiO_4. (*C.A.*)

Pythagoras ware. ANON. *Chem. and Ind.*, **48**, 555 (1929).—A new super-porcelain has been developed by the Haldenwanger firm of Berlin-Spandau, and by them named "Pythagoras Mass." It melts at cone 37–38, is gas-tight to very high temperatures, resistant to all kinds of chemical action, and insensitive to sudden changes of temperature, so that articles made of it can be taken directly out of a hot furnace without cracking. The composition and method of manufacture are not given. H.H.S.

Unusual features of firebrick plant. ANON. *Fuels and Fur.*, **7** [1], 99–102 (1929).—A complete description is given of the Salina plant of the Kier Fire Brick Co., Pittsburgh, Pa. A.E.R.W.

PATENTS

Brick and cement for furnace use. RUSSELL P. HEUER. U. S. 1,714,506, May 28, 1929. The process of making a chrome refractory brick from clay and chrome ore containing combined magnesia, which consists in adding to a body of chrome ore a small quantity of clay and magnesia in sufficient quantity to prevent softening reaction between the clay and the chrome ore at high temperatures, and a solution of a salt which will yield magnesium ions in the mixture.

Making refractory composition. THOMAS S. CURTIS. U. S. 1,715,449, June 4, 1929. A refractory composition consisting of the reaction product of a mixture of magnesia and iron oxide containing not less than 35% and not more than 50% of iron oxide, and the mixture having been heated to a sufficiently high temperature to cause reaction between the magnesia and iron oxide and sintering of the product.

Making refractory composition and articles. LOUIS J. TROSTEL. U. S. 1,716,295, June 11, 1929. The process which comprises adding cyanite to a highly aluminous clay mix, shaping the mass, and subjecting it to heat whereby expansion of the silicate will substantially balance shrinkage of the clay to produce a refractory article having a substantially constant volume.

Refractory composition for hot tops. EUGENE L. MESSLER. U. S. 1,717,575, June 18, 1929. A composition for ingot mold hot tops and plugs comprising flint clay in the relative proportion of 40 to 60%, grog in the relative proportion 10 to 20%, and plastic clay.

Refractory materials. UNITED STATES METALS REFINING CO. Fr. 33,578, May 6, 1927. (Addn. to 607,611.) In the manufacture of molded refractory materials the magnesite used is powdered to different degrees of fineness, before its mixture with siccative oil so that during mixing and molding the fine particles penetrate between the larger and give a denser product. (*C.A.*)

Refractory masses. G. POLYSIUS EISENGIESSEREI. Ger. 470,422, Oct. 9, 1925. (Addn. to 464,312.) Ger. 464,312 describes the manufacture of refractory masses, intended particularly as furnace linings, by calcining a mixture of a fusible cement with suitable additions such as corundum. Such products are now improved by providing a dense surface on the fire side and a porous surface on the side away from the fire. This is done by using coarse granules of corundum for the side away from the fire and finer granules for the fire side. (*C.A.*)

Refractory bodies. HERMANN SALMANG AND FLORENZ GOETH. Ger. 474,415, May 28, 1927. Refractory bodies of improved properties are prepared by heating the

initial materials to softening temperature under strong pressure, *e.g.*, a refractory clay is heated in a C mold to 1450° under a pressure of 4 kg. per sq. cm. (*C.A.*)

Terra Cotta

Lights and color. ANON. *Brick Clay Rec.*, **74** [11], 740–42 (1929).—Modern practice in architecture is rapidly developing the use of color and the employment of floodlight to enhance its handiwork. This development is especially true in the designing and building of our modern skyscrapers. Clay products have been found to be the materials with which the architect may best realize his dreams of color and light. One material used in building construction that offers great facility in creating night architecture is terra cotta. The material has no limitations as to form and color, and with tests by the General Electric Co., it has been shown that this material has greater powers of light reflection than any other material. Some of the present outstanding structures illustrating the beauty and practicability of a floodlighted terra cotta building are described. One in particular is floodlighted by means of 30 changes in color. E.J.V.

Colored tile chimney tops. ANON. *Arch. & Bldg.*, **61** [3], 98 (1929).—The chimney top is an architectural adornment. Its decorative possibilities were recognized at an early date and chimney tops of highly ornamental character are familiar objects. The W. S. Dickey Clay Mfg. Co. (Kansas City, Mo.), have put upon the market in a considerable variety of designs a line of colored chimney tops. The colors offered, buff, blue, and green, are kiln fired and permanent. E.P.R.

Metal coated cement. ANON. *Cement, Mill & Quarry*, **34** [6], 66 (1929).—Cement objects, sprayed with metal, were recently shown in Germany. The process is said to render the material waterproof. Molten tin, zinc, or lead was sprayed over cement and concrete slabs, tanks, and pipe. The process is said to have been successful also in covering all other form of artificial stone. E.P.R.

Madison Hospital, New York City. ANON. *Arch. & Bldg.*, **61** [3], 163 (1929).—The exterior of the 15-storied Madison Hospital building is finished in red brick with rough hard fired bats laid into the walls giving a rough textural effect. Tile is used for ornaments about the lower stories in a sparing way. E.P.R.

Ceramic architecture in churches. ANON. *Arch. & Bldg.*, **61** [3], 135–36 (1929).—The interior of the Church of Heavenly Rest, New York City, is of a warm tone sandstone and its vaulting is of tile with a glint of gold; the organ screen is a tracery of stone work, hiding the organ pipes; the altar is a great block of limestone and rising behind it is a sandstone reredos; the rose window has rich coloring in its glass. E.P.R.

New York Central Building. ANON. *Arch. & Bldg.*, **61** [3], 138 (1929).—Description of new building is given in detail. E.P.R.

New York Life Insurance Company's Building. ANON. *Arch. & Bldg.*, **61** [3], 71 (1929).—The exterior is of Indiana limestone; roof surfaces are heavily waterproofed and tiled; main story halls are walled with Travertine; the ceilings are of ornamental plaster decorated in colors; and for a distance of 100 ft. the ceiling is a barrel vault with a height of 38 ft. from the floor. E.P.R.

Durability of glazed terra cotta. ANON. *Morning Post*, May 11, 1929.—An investigation in London has shown the relative scarcity of faulty terra cotta as compared with faulty stonework. At Buckingham Palace a frieze of glazed terra cotta shows no signs of decay although a century old, and gargoyles of the same age are in excellent condition. Albert hall (built in 1867), shows no signs of weathering, yet a new south porch erected in the present century of a different terra cotta is already disintegrating. H.H.S.

BOOKS

Sounding Stones of Architecture. PHILIP N. YOUTZ. W. W. Norton & Co., Inc., New York., 268 pp. Price $2.50. Reviewed in *Arch. & Bldg.*, **61** [5], 164 (1929).—The group of essays presents a critical viewpoint which has not been attempted by recent writers. E.P.R.

Styles of English Architecture. Part I. Middle Ages. ARTHUR STRATTON. J. B. Lippincott Co., Philadelphia., 32 pp., illus., price $1.00. Reviewed in *Arch. & Bldg.*, **61** [5], 164 (1929).—The book is intended as a companion to a series of large-scale comparative diagrams (30 x 20 in.) which are for the use of schools, teachers, and students. E.P.R.

PATENT

Forming roofing tile. ERNEST W. EKSTRAND. U. S. 1,713,754, May 21, 1929. In an apparatus for forming tile, the combination of means for mixing clay with water, a die secured to the mixing means and through which the clay is extruded as a ribbon, a plate mounted adjacent the die, means mounted above the plate for cutting the ribbon to form slabs of predetermined length, a saddle mounted below the surface of the plate and onto which the slab is slid, the saddle having a handle by means of which the slab and saddle are lifted, and trimming means over which the saddle is drawn to trim the edges of the slabs so that the slab fits the saddle.

White Wares

Relation of a modulus of grain size to the mechanical strength of sagger mixtures. RAYMOND E. BIRCH. *Jour. Amer. Ceram. Soc.*, **12** [7], 451–54 (1929).—A series of sagger mixtures is prepared with grain size varied on a calculated fineness modulus. Both dry and fired strength are related to grain size and a striking maximum point is obtained.

Progress report on investigation of sagger clays. V. Preparation of experimental sagger bodies according to fundamental properties. R. A. HEINDL AND L. E. MONG. *Jour. Amer. Ceram. Soc.*, **12** [7], 457–80 (1929).—This is a Fifth Progress Report giving the results obtained in a preliminary study of sagger bodies, which is a continuation of an extensive investigation of sagger clays for the purpose of determining the properties of clays and bodies best suited for sagger purposes. The report contains data on the modulus of elasticity, transverse breaking strength, plastic flow, thermal expansion, and resistance to failure due to heat shock of 55 sagger mixes representing 39 different bodies fired at either 1230 or 1270°C. The 16 bodies prepared in duplicate were tested both after firing at 1230 and 1270°C. All of these bodies were compounded with two clays whose properties are given in earlier progress reports, and a mixture of graded grog. The grog was graded into sizes so as to result in two types of bodies, those having (1) a coarse and open-grained structure and (2) a dense and fine-grained structure. The data on the fired bodies show that those containing the fine sizes of grog have the higher modulus of elasticity, transverse strength, and in the majority of cases, thermal expansion. Very little difference in total porosity of the two types of bodies is indicated although the rate of absorption shows large differences. The data obtained in this preliminary study indicate that those bodies having (1) a porosity of less than 25%, (2) a low modulus of elasticity, (3) as high transverse strength as is compatible with the low modulus of elasticity, and (4) low thermal expansion below 250°C, are the most desirable for sagger purposes.

Present practice in whiteware periodic kiln design. R. G. MILLS. *Jour. Amer. Ceram. Soc.*, **12** [7], 481–90 (1929).—Tables of whiteware kiln dimensions and design ratios are presented. Distribution charts are included which show the present tendency in kiln size and kiln design factors. Attention is called to the wide variations

found in some of the design factors and to the rather narrow limits within which others fall.

Stoneware clay for dry-press tile. ANON. *Ceram. Ind.*, **12** [6], 657–58 (1929).—Considerable insight was obtained as to causes of pinholing or egg-shelling of the glazes used at the plant of the A. E. Hull Pottery Co. It was found that the greater amount of non-plastics used in the glaze, the longer grinding time was required. If the additional grinding time is not given a glaze with a large amount of non-plastic in it, it is very apt to pinhole or egg shell. This particular phenomenon applies to mat, as well as bright glazes, and especially in barium mats. Many of the glazes used at this plant are of the crystalline nature, and it was found that the glaze if ground to pass a 60-mesh, but no finer, would give the best result. It was found that after the glaze was ground to pass 60-mesh, an additional 45 minutes' grinding reduced the possibilities of crystalline formation. In preparing the faience glazes, all raw materials used should be regularly tested, and the least amount of fritted materials used in the glaze, the better. A raw, low-fire mat glaze of the crystalline type, it is said, will not scratch as easily as a fritted mat fired at the same temperature. It was found that in glazes containing lead and zinc, much better results were obtained if the lead and zinc were ground 2 hrs. and dried out before being reincorporated in the glaze. This treatment made the lead and zinc remain in suspension better and enabled a more uniform distribution throughout the glaze mass. Better results from dipping were obtained when the lead and zinc were so treated. A novel use of an organic material was found in the course of an investigation. If, in a regular cone 5 to 6 mat glaze, 7% of lactone is added, a beautiful enamel results. F.P.H.

Tile floors over wood joists. WILLIAM F. LOCKHARDT. *Amer. Home*, 404 (1929).—The manner of laying ceramic tile over wooden floors is described as follows: (1) boards 1/4 in. apart, (2) tarred felt, (3) concrete slab with reinforcing mesh, (4) leveling mortar, and (5) tile. T.W.G.

Hohburg kaolin in a porcelain body. FREDERICK C. SCHROEDER. *Ceram. Ind.*, **12** [6], 659 (1929).—Properties of Hohburg kaolin: (1) dry shrinkage, 4.6% and (2) dry tensile strength, 10.5 kg. per sq. cm. Firing properties to cone 14 test made in commercial porcelain kiln.

Temperature in cones	Firing shrinkage	Total shrinkage	Porosity
10	2.4	6.9	31.4
05	3.1	7.6	30.7
1	5.7	10.0	22.8
6	8.2	12.4	19.6
10	11.6	15.7	13.6
14	13.7	17.7	8.4

Refractoriness: cone 34 flat.

Chemical analysis of Hohburg kaolin:	Dried at 110°C	Ignited
Ignition loss	11.51	
SiO_2	55.27	62.46
Al_2O_3	31.56	35.66
Fe_2O_3	0.63	0.71
TiO_2	0.48	0.54
CaO	0.10	0.11
MgO	trace	trace

Rational analysis: (Berdel method)	
Clay substance	82.6
Quartz	16.3
Feldspar	1.1
	100.0

It is said that in Germany electrical porcelain manufacturers, making low-tension type porcelains, have used for their body only kaolin and sand. The kaolin which has been used is known as Hohburg Kaolin H1a. It fires snow white and is said to be exceptionally plastic. F.P.H.

Pottery industry in North Staffordshire. II. JOSIAH C. WEDGWOOD. *Pottery Gaz.*, **54** [624], 964–66 (1929).—In 1828, Minton began to manufacture encaustic tiles, but it was not until 1840 that dry pressed tile were first made. Statistics regarding production are contrasted in order to trace the growth of the industry. The strike of 1836, the workers' prejudice against machinery, "great days" in the pottery industry between 1820 and 1850, barter in employment, workers' unions, new inventions, and Government interference are also discussed. For Part I see *Ceram. Abs.*, **8** [7], 514 (1929). E.J.V.

PATENTS

Tile-making machine. CLARK E. MUMMA AND CLARENCE M. MUMMA. U. S. 1,714,614, May 28, 1929. A tile-supporting mandrel, a vertically movable punch frame associated therewith, means for operating the punch frame and automatic means for periodically interrupting the operation thereof.

Insulator. ARTHUR O. AUSTIN. U. S. 1,715,888, June 4, 1929. (1) An insulator comprising a hollow dielectric body, a support secured to the body, a flux distributing screen having electrical connection with the support and extending beyond the support into the interior of the body, and a dielectric covering for the screen separating the screen from a portion of the opening within the body. (2) An insulator comprising a dielectric member having an opening adjacent one end thereof, the interior of the opening being coated with conducting material, a support secured to the end of the insulator adjacent the opening, and an external flux screen carried by the support. (3) In combination, a tubular dielectric member, a support connected with one end of the tubular member, a cup-shaped dielectric member extending into the tubular member and having its open end connected with the support, and a flux screen of conducting material extending into the cup-shaped member.

Insulator. ARTHUR O. AUSTIN. U. S. 1,715,889, June 4, 1929. In combination, an insulator bar, a cap secured to one end of the bar and a plurality of flux screens mounted on the cap and disposed about the bar in spaced relation to one another, each screen comprising a conductor member extending from the cap outwardly and along the bar, and a covering of dielectric material disposed over the end of each of the conductor members.

Insulator. WALTER T. GODDARD. U. S. 1,716,123, June 4, 1929. (1) In an insulator including superposed nested shell members having outstanding portions, means for suppressing corona consisting of successive masses of dielectric material partially filling the spaces between the successive outstanding portions, the outer surfaces of the successive masses being continuations of one another and conforming to the lines of the electrostatic field. (2) The method of suppressing corona in insulators of the type including a plurality of nested sections each having an outstanding portion, consisting in applying between the successive sections a plastic filling of dielectric material of a nature other than that from which the insulator parts are formed, shaping the filling between the successive sections whereby the outer surfaces thereof will all be in continuation and substantially coincide with lines of the electrostatic field, and permitting the material to harden.

Tile. PETER C. C. FRIDERICHSEN. U. S. 1,716,224, June 4, 1929. A ceramic nosing tile unit for the outer end of a course or courses of ceramic tile units comprising a rigid body portion open at each side and at its rear and formed of ceramic material, the body portion consisting of a rearwardly extending, horizontally disposed flat upper

part and a forwardly and rearwardly directed outer part depending from the forward end of the upper part, the outer part having the free end edge thereof positioned below the upper part and substantially in alignment with the point of mergence of the upper part with the lower part, the body portion of uniform thickness throughout, and having the end edges thereof squared throughout, the inner face of the outer part having projecting rearwardly therefrom transversely extending, spaced dovetailed tongues corresponding in length to the width of the outer part, one of the tongues spaced from the upper part and another of the tongues spaced from the free end edge of the outer part.

Insulator. ROBERT M. JOHNSTON. U. S. 1,716,963, June 11, 1929. (1) A high-tension insulator comprising a dielectric unit, a slotted metal cap having its edge provided with attaching means engaging the insulating unit, and a suspending member having a head capable of passing through the slot of the cap and turned so as to normally extend transversely with respect to the slot, a portion of the suspending member, where it extends through the slot being of angular cross-section so that it will coöperate with the sides of the slot to prevent relative rotation and consequent accidental disengagement of the cap and the suspending member. (2) In a high-tension insulator, a suspending device comprising a body provided with an elongated T-shaped end of approximately the same thickness as the contiguous portion of the body thereof, a portion of reduced cross-section, and a portion of angular cross-section located between the head and the reduced portion. (3) In a high-tension insulator, a suspending device comprising a body having T-shaped extremities, a middle portion of reduced cross-section, and portions of angular cross-section between the middle portion and the T-shaped extremities.

Making insulators. STEWART L. MOORE, JR. U. S. 1,717,996, June 18, 1929. In a machine of the character described, relatively movable mold members adapted to compressingly engage and shape plastic material, and means for applying air pressure through one of the mold members upon the plastic material.

Pottery making. W. J. MILLER. Brit. 308,836, May 23, 1929. A machine for jigging pottery is provided with means for intermittently establishing an abnormal atmospheric condition in the molds through the supporting means therefor. The molds are either formed of porous material or have holes communicating by means of pinhole slots with the charge-receiving surface of the mold. Suction or air under pressure is applied intermittently through the hollow chuck spindle, chuck, and porous or perforated mold so as to insure adhesion of the charge to the mold or ejection of the shaped ware from the mold. The apparatus, including electromagnetic means or a coöperating stud for holding the mold onto the chuck during the shaping operation or ejection of the ware, is identical with that described in Specification 285,871 (see *Ceram. Abs.*, **7** [7], 463 (1928)), and such apparatus together with the suction or pressure applying means is described in the published abridgment of such Specification. Suction may also be applied to the mold so as to facilitate the feeding of the material to the mold and prevent adherence of the material to the die.

Feeding plastic ceramic materials to molds. WM. J. MILLER. Fr. 647,763, Jan. 17, 1928. (*C.A.*)

Ceramics. HARRY ZIMMER. Ger. 472,743, April 24, 1927. Porcelain objects are made by pouring layers of varying granular texture into the mold. (*C.A.*)

Equipment and Apparatus

Exhibit of photo-elastic apparatus. ADAM HILGER. *Trans. Optical Soc.* [London], **30** [3], 135–36 (1928–29).—Photo-elastic equipment is described, which is used to deter nine the stress distribution in parts of machines and structures by observations mad : on models constructed of transparent materials. By suitable calibration mea-

surements the stresses evidenced by the strain shown in polarized light are evaluated directly in pounds or kilograms as desired. A diagrammatic sketch of the apparatus is shown together with two photographs of test pieces in plane polarized light and in circular polarized light. J.T.L.

Carboloy. E. G. GILSON AND G. N. SIEGER. *Abrasive Ind.*, **10** [5], 20–22 (1929).—Before tungsten carbide can be used to any extent commercially, a number of obstacles will have to be overcome, the greatest of which appears to be the insufficient rigidity of present-day machine tools to support the work so that it can be machined effectively. Tungsten carbide has been used in place of diamond tools for cutting nonmetallic materials, and to machine Hadfield's manganese steel which heretofore was considered unmachinable with ordinary cutting tools. With modern massive surface grinders carrying sectional bakelite wheels 36 or more inches in diameter and driven at peripheral travel in excess of 7000 ft. per min., excellent results have been shown. Manganese steel has been ground at the rate of over 200 cu. in. an hour metal removal as an everyday production operation. It is doubtful if the new alloy will show efficiency over the grinding wheel for finishing manganese steel on a production basis. Basically, carboloy is cemented tungsten carbide, the cementing material being cobalt. It has a density of about 14.5. In hardness it will scratch the sapphire and is next to the diamond on the absolute scale. Its strength is only about one-half that of high-speed steel. As far as is known, it is inert to ordinary atmospheric influences, for after years of standing around it shows no deterioration or even tarnish. Some of the strong chemical agents will attack it as might be expected. As to oxidizability, being basically tungsten it behaves like all of the tungsten compounds, oxidizing easily at the higher temperatures. In its nature carboloy is unlike those metals which are fused or cast, although in appearance it is similar to steel and a fracture of a broken piece has a marked resemblance to that of a piece of heat-treated high-carbon steel. The physical characteristics are, however, entirely dissimilar to those of steel. It is safer to consider the material more like the diamond or a piece of glass than a metal. It seems to have an entire lack of ductility. Its thermal expansion coefficient is low. Its heat conductivity is low. These, combined with its lack of ductility, causes it to be cracked easily or broken when subjected to rapid temperature changes or sharp temperature gradients. Interest in carboloy at the present time lies more especially in its use as a cutting tool, and the extent to which its unusual properties may affect machine-shop practice or machine-tool design. It has been applied to cutting a wide range of materials; nonmetallic substances, such as fibers, nonferrous compounds, such as copper, brass, soft bronze, very tough bronze, copper tungsten, "elkonite," aluminum, and its alloys as used more especially in the automotive industry; and ferrous metals, such as cast iron with its hard and sandy inclusions and hard scale, carbon steels, and many of the alloy steels. E.P.R.

Mechanical preparation of minerals. I. M. V. CHARRIN. *Sci. et ind.*, No. 181, pp. 79–86 (1929).—C. gives a detailed review of the subjects of crushing and grinding, classification, and concentration of minerals: **II.** *Ibid.*, No. 183, pp. 238–40.—The subject of enrichment by flotation is discussed. Various types of apparatus are shown and schematic diagrams are used to explain industrial installations. A.J.M.

Differential manometer functioning by air under pressure; velocity and flow of fluids. F. BORDAS AND F. TOUPLAIN. *Bull. soc. encour. ind. nat.*, No. 3, pp. 257–65 (1929).—The following points are discussed in detail: I. Determination of flow by the use of manometers: (1) general considerations, (2) differential manometer of one or two liquids furnished with Pitot tubes and functioning by means of air under pressure. II. Principles and characteristics of the manometric system: (1) simple manometer; (2) differential liquid manometer; (*A*) remarks and observations: (*a*)

Influence of the aperture of the air exit tubes, (*b*) density of manometric liquids; (3) manometer of 2 liquids: (*A*) The law regulating its functioning; (4) static and dynamic outlet tubes. III. Installations of the apparatus: (1) manometer apparatus and its accessories, (2) one-liquid manometer, (3) two-liquid manometer; (A) manometer scales, (B) mode of operating, (C) calibration of the apparatus, (D) characteristics and advantages of the process. IV. Recording manometer. A.J.M.

Screw conveyer accidents. J. B. JOHN. *Cement, Mill & Quarry*, **34** [6], 36–39 (1929).—The first step in solving the problem of screw conveyer accidents is to cover the mechanism so effectively that the workmen cannot possibly be caught in it. E.P.R.

Mine scraper hoist. ANON. *Cement, Mill & Quarry*, **34** [6], 66 (1929).—American Hoist & Derrick Co. has just issued a folder that describes and completely illustrates its American mine scraper hoist. The hoist is operated by compressed air. Some of the outstanding features are: piston valves, band type frictions, cast steel cut stub tooth gears, and Alemite lubrication all over. E.P.R.

Protective coating for equipment. ANON. *Clay-Worker*, **91** [7], 586 (1929).—Opalite, the protective coating which was introduced to the brick, clay, and ceramic industry in Chicago in Feb., has proved excellent for protection against the acid and alkali vapors, moisture, sulphurous fumes, heat, and hot acid and alkali fumes, the condensation caused by acid and alkali fumes mixed with the evaporation of moisture from clay products which create sulphurous acids and rapidly destroy drier cars, structures, and all equipment. E.J.V.

Installation of CO_2 meters. ANON. *Brick Clay Rec.*, **74** [13], 888 (1929).—The Brown Instrument Co. has worked out an ingenious method of installing CO_2 apparatus, working on the thermal conductivity principle. In this system of analyzing gases, the relative capacity of air to conduct heat as compared with the gas to be analyzed is used to operate electrical indicating and recording instruments calibrated directly in per cent CO_2. A detailed description of this method is given. E.J.V.

Chain feeder controls flow of materials. ANON. *Brick Clay Rec.*, **74** [13], 888 (1929).—A curtain-like endless chain feeder which controls the flow of materials from storage hoppers and open dump-chutes, manufactured by the Ross Screen & Feeder Co. (N. Y.), under the name of the Ross Feeder, is described and its advantages are enumerated. E.J.V.

Location finder in microscopes. JEAN BROADHURST. *Science*, **69**, 195–96 (1929).—The difficulty of finding a particular portion on a microscope slide is overcome by the use of a lined chart (graph) on the ordinary stage and an aluminum stage-square to keep the slide aligned with the chart. H.H.S.

BOOKS

New Book on Altimetry. AMERICAN PAULIN SYSTEM, INC. *Cement, Mill & Quarry*, **34** [6], 68 (1929).—The technical and educational departments of the American Paulin System, Inc. (Los Angeles), have compiled a 16-page manual on altimetry. It treats with the subject of altimetry as it applies to all phases of engineering, exploring, mining, geology, topography, construction and science, and kindred subjects. E.P.R.

Filter cloth investigations. K. ŠANDERA. Exp. Inst. Cz. Sugar Ind. Prague, *Listy Cukrovar.*, **47**, 284–88 (1929); cf. *C. A.* **23**, 2317.—In studying the effect of pressure upon the edges of cloths which are pressed against the frames, Š. found a loss of strength if projections occurred between the cloth and frame, either as roughness, sediment deposits, or sand. Low pressures (55 kg. per sq. cm.) have an insignificant effect; higher pressures (100 to 550 kg. per sq. cm.) lower the strength. Unfolded cloths were subjected to 550 kg. per sq. cm. for 10 mins.; the tensile strength of cotton fell 66%, of jute 90%. Cloths which were folded and subjected to 550 kg. per sq. cm.

disintegrated under a slight pull; 440 kg. per sq. cm. left only one cloth intact; for 330 kg. per sq. cm. cotton cloths retained 10 to 20% of their original strength, jute 12.5%. Sand placed between the leaves of the cloths in the press and subjected to 550 kg./cm.^{2} decreased the strength of wet cotton cloths 50 to 83%, of jute 75 to 92%, of linen 55%. Linen is very resistant to the crushing action of sand when wet; it does not resist this action when dry. Folding a wet cloth before compression is detrimental; cotton cloths lost 51 to 88% of their tensile strength, jute and linen 100% (the cloth was sheared at the fold by the pressure). Damp cloths were clamped between two 2 mm. steel wires and placed over a tray of H_2O containing a normal amount of CO_2. After 5 days the tensile strength was determined. The tensile strength decreased 6 to 28%; in all cases the tear occurred in the region of contact with the steel wire. On soaking the cloths in an alkaline medium (CaO solution), the rusting was retarded, and the decrease in tensile strength was within the experimental error. The resistance to impact delivered by an automatic hammer (2750 g.) dropping 200 mm. was best in cotton cloths; a thicker cloth is more resistant than a thin one. The effect of impact was greatest in used cloths. Artificial incrustation with $CaCO_3$ by impregnating the cotton cloths in a CaO solution and placing them in an atmosphere with CO_2 or a solution with CO_2, decreased the flow of distilled H_2O by 5%; for thick cotton cloths the rate of flow was decreased 50 to 66%, for liquors 15 to 26° Bé., for thin cloths only 33%. Incrustation has the greatest effect upon jute cloth, decreasing the flow 66 to 75%; the effect upon linen-cotton cloths is the same as for thick cotton ones. (*C.A.*)

Vibrating screen. EMIL DEISTER. U. S. 1,717,498, June 18, 1929. A vibrating screen comprising a frame, means to support the frame in adjustable inclined position, a screening medium supported on the frame means, connected to the screening medium and coöperating with the frame to place tension on the medium, a cantilever beneath and extending longitudinally of the screening medium and connected at one end to the medium, means mounted at the opposite end of the cantilever to cause it to vibrate and a resilient member secured to the frame and extending across the same beneath the screening medium and also secured to the central portion of the cantilever.

Apparatus for weighing continuously moving granular material. JOHANNES IHLEFELDT. U. S. 1,717,564, June 18, 1929. Apparatus for weighing granular material, comprising means for moving granular material in a continuous path, the means including a balance beam carrying on the one of its sides a conveying device, a motor mounted on the other side of the balance beam, and operative connecting means between the motor and the conveying device.

Extraction of clay. CHEMISCHE FABRIK IN BILLWARDER. Fr. 647,928, Jan 28. See Brit. 286,456. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

New type high temperature fusion furnace. J. B. SHAW AND G. J. BAIR. *Jour. Amer. Ceram. Soc.*, **12** [7], 447–50 (1929).—The limitations of carbon, gas, and electric furnaces for high-temperature fusion are discussed. The new oxyacetylene furnace controls the atmosphere in contact with the test cones, protects furnace parts, and insures uniform conditions throughout the furnace.

Continuous furnaces for reheating alloy blooms. ANON. *Fuels and Fur.*, **7** [1], 55–58 (1929).—A complete description and sketches of two large continuous reheating furnaces are given. A.E.R.W.

Stoker-fired tunnel kilns for firing fire brick. D. B. HENDRYX. *Fuels and Fur.*, **7** [2], 225–28 (1929).—A description is given of one of the first successful installations of stoker-fired tunnel kilns. At the press the brick are placed on tunnel kiln cars and

taken to humidity driers, then to the kiln. The kilns are 442 ft. long and hold 59 cars each. Six stokers are on each side operated from 2 line shafts which are driven from a single motor through a variable speed transmission. Coal is dumped onto a reciprocating plate feeder discharging into a hammer pulverizer where it is broken down to a size of $^1/_2$ in. and smaller. It is then elevated into a storage bin from which it is carried by electric monorail carrier to the individual hoppers over the stokers. The stokers are of the underfeed screw type, ratchet driven, and are operated under forced draft. The fireboxes are set entirely outside of the kiln structure and the hot products of combustion enter the kiln tunnel through wide arches set at about car-top level. The hot products of combustion are distributed underneath the setting of brick and allowed to filter up through it. The temperature variations throughout the load are very slight, and the brick are fired very uniformly. A.E.R.W.

Kilns for firing refractories. ANON. *Refrac. Jour.*, **4** [44], 233–44 (1929).—Although the first tunnel kiln was introduced more than one hundred years ago, only recently has it made rapid progress in favor. The tunnel kiln is an attempt to combine the many good points of present kilns, both of the downdraft and chamber type, avoiding perhaps, some of their shortcomings. Scumming, blistering, black core, and other defects caused by the products of combustion and moisture condensing on the goods, are practically eliminated, resulting in a clean and uniformly fired product. The kiln may be fired by gas, oil, or coal direct, is easy to control, and capable of attaining high temperatures. There are five successive zones: preheating, heating, equalizing, furnace, and cooling zones, the goods first entering the preheating zone. A detailed description of the E.I.C.T. kiln is also given together with a discussion of the different kilns. E.P.R.

Archless continuous kiln. ANON. *Brit. Clayworker*, **38** [445], 46–47 (1929).—A description is given of a new type of archless continuous kiln which has recently been installed by the Hamstead Brick Co., Ltd. (Birmingham, England). It is the invention of Alvis Habla of Czechoslovakia. The kiln is 84 ft. long and 63 ft. wide and is of the zigzag Hoffman type. It comprises 3 longitudinal parallel walls of substantial construction having the novel characteristics that each contains a smoke flue and a hot air flue. The openings, into or out of the smoke flues are situated to correspond with the back ends of the zigzag chambers which are 20 ft. long by $7^1/_2$ ft. wide. The smoke flues in the external walls are connected together at both ends of the kiln by means of underground flues and also with the center wall flue at the fan end. The advantage of this feature is that the width of the kiln, and the corresponding length of the firing chambers may be greater than in the solid built zigzag kilns and with corresponding increase of draft the production of a single kiln may be increased to a high figure. The second feature of the invention is that the division walls which usually support the narrow transverse arches in this type are built of green brick which are fully fired and are removed for sale at each round. These walls are transverse to the kiln structure and stopped 6 ft. short of the outer and middle walls alternately so that the fire-travel is zigzag and the total length of the 20 firing chambers is 416 ft. The walls are 9 ft. high of which the top foot or more is occupied, in setting the kiln, by one or two courses of fired brick laid close, flatwise and breaking joint followed by a bed of dry sand. The feedholes and covers are set at the required spacing in this temporary covering and are removed after firing. Drawings showing dimensions are included. R.A.H.

Economics of insulating industrial heating equipment. I. J. D. VAN VALKENBURGH. *Fuels and Fur.*, **7** [1], 49–70 (1929).—V. discusses the insulation of ovens and furnaces with reference to the savings which result from the conservation of heat and improved plant and working conditions. The bare heat loss of uninsulated furnaces

often amounts to a matter of several dollars per sq. ft. per yr. The insulation of a furnace causes the temperature gradient through the brick to be reduced in slope which lessens the internal stresses and lightens the load on the refractories. The tendency for the brick to spall is decreased, and it is possible to use lower maximum temperatures in the firing zone and still secure adequate temperatures throughout all portions of the furnace. Charts are included which show heat losses and their cost for various operating conditions. **II.** *Ibid.*, **7** [2], 277–82 (1929).—Charts are presented in which heat loss is plotted against temperature. By means of these charts the economical thickness of insulation for continuous or intermittent operation may be determined. Examples of installations and some cost figures are given. A.E.R.W.

Thermal insulation of kilns. C. PRESSWOOD. *Ceram. Age*, **12** [6], 242–43 (1928).—A summary of P.'s remarks before the National Assn. of Clayworks Managers is reprinted from *Claycraft* (England). *I. Inefficiency:* The efficiency of brick kilns has been increased by (*a*) building of kilns, flues, and stacks so as to concentrate the heat on the ware, (*b*) use of forced draft, and (*c*) use of continuous kilns. Efficiency calculations, however, show that a great deal of heat is still wasted. P. points out, *e.g.*, (*a*) the difference in fuel consumption in wet and dry, hot and cold weather, (*b*) hissing of rain on kilns, (*c*) rapid drying of yard immediately over flue, (*d*) outer kiln walls warm to the touch, (*e*) radiation felt 4 or 5 feet from kiln, (*f*) hot ground found when kilns are pulled down, and (*g*) upward draft over hot kiln. As much as 25% of the heat may be lost. *II. Thermal insulation:* Thermal insulation may save 17 to 18% of the fuel. It permits the use of thinner walls. P. points out the factors to be considered in choosing bricks for kiln construction. A.E.R.W.

Results of firing clay. A. T. GREEN. *Ceram. Age*, **12** [3], 104–105 (1928).—(Presented at Derby and Notts Branches of the Natl. Assn. of Clayworks Managers; reprinted from *Claycraft* (England)). G. points out that clay consists of clay-substance, quartz, iron and lime compounds, carbonaceous matter, feldspars and micas and that if the existence of any of these substances is ignored, troubles will be encountered in firing. The firing may be divided into various operations, *viz.*, watersmoking, oxidation, and vitrification. *I. Water-smoking period:* It is not economically possible to eliminate all the water before firing, about 1 to 3% being usually retained. This water is probably colloidal and is driven off at about 150 to 170°C. Too rapid firing causes rapid steam evolution and damages the brick. For this reason 60 to 70 hrs. are sometimes required to raise the temperature of a downdraft kiln to 260°C. The formation of iron and sulphur compounds on the ware takes place at 600°C. If water vapor is removed rapidly, water-smoking can be carried out rapidly, 10 to 12 hrs. sufficing in some continuous kilns. *II. Oxidation period:* With most clays, 400 to 700°C is the oxidation period during which all the carbon must be removed. If the temperature reaches 800°C before complete oxidation, slaglike compounds of iron and silica are formed which prevent further oxidation. At 575°C and during the oxidation period, the clay substance breaks down, water is driven off, and the alumina and silica are separated. The clays are then at their weakest mechanical state. *III. Vitrification:* Vitrification starts at 810°C. It is influenced by both time and temperature. The heat work required to produce a certain degree of vitrification depends on the clay used. At 900°C, the iron, sulphur, and silica compounds break down, sulphur is driven off, and black ferrous silicate is formed. Most of the sulphur comes, originally, from the coal. Crystallization occurs during the vitrification period. At 1000°C the silica and alumina tend to recombine forming acicular crystals. At 1200°C, quartz shows a definite tendency to change to other forms of silica, increasing 13% in volume. This must be considered when the advisability of adding quartz to clays is being discussed. Manufacturers should determine the changes in specific gravity and porosity

which take place on firing. Data from such determinations are shown in charts. The curves indicate the reaction which occur on firing and afford a guide to the exact time and temperature for firing off. The thermal efficiency of a downdraft kiln is about 20% whereas that of a tunnel kiln is 60 to 70%. Tunnel kilns, however, are inelastic units. The discussion contains questions and answers on the following topics: (1) overfiring salt-glazed insulators, (2) insulation of kilns, (3) pyrometers, (4) black specks, (5) black cores, (6) water-smoking, (7) coke vs. coal, and (8) light centers in a salt-glazed pot. A.E.R.W.

Reducing firing time. ORVILLE ADAMS. *Brick Clay Rec.*, **74** [12], 800–802 (1929).—The lignite in the (Bridgeport Brick Co.) shale continues to burn after the fire is off, reducing the hours of firing and the fuel consumption. Complete combustion of low-grade fuel oil is obtained. A bright-colored brick is produced in both oversize and standard. There are very few waste brick. Fuel consumption is from 60 to 75 barrels of oil for 350,000 brick, with the necessary gas to assist in firing the first few chambers. The cost is further reduced by the omission of any apparatus for atomizing. The cost of the production is very low and the figures have not been made public. Doubtless a large field of research both in firing and in use of lignite is suggested by this experience. Some of the important points enumerated suggest the need of further study with the hope of applying them to other plants. E.J.V.

Electrical cleaning of blast-furnace gas. ROBERT DURRER. *Blast Fur. Steel Plant*, **17** [6], 862–63 (1929).—Gas cleaning by electrical precipitation has been simultaneously worked out in the U. S. and in Germany. Fine cleaning is required in European plants for gas engine operation. F.P.H.

Recent progress in gas engineering. LESLIE B. BRAGG. *Gas Age-Rec.*, **63** [22], 741–45 (1929).—For convenience in treatment, the subject has been divided into four major parts: gas, by-products, coal, and equipment. F.P.H.

Principles of gas and fuel engineering. I. D. J. DEMOREST. *Fuels and Fur.*, **7** [1], 73 (1929).—This is the first of a series of articles dealing with the application of mathematics, chemistry, physics, and economics to gas and fuel engineering. Fuels are used for three purposes: (1) for heating, (2) for power generation, and (3) as chemical reagents. A comparison is given between fuels and other materials used in these fields. Complete classifications of plant compounds and coals are shown. A.E.R.W.

Formation and composition of coal. II. D. J. DEMOREST. *Fuels and Fur.*, **7** [2], 209–12 (1929).—A general discussion of the formation of peat bogs, the decay of organic materials, and the action of bacteria. D. also describes the coalification of these formations and the composition of the coal. A.E.R.W.

Nature and origin of petroleum and natural gas. III. D. J. DEMOREST. *Fuels and Fur.*, **7** [3], 359–61 (1929).—D. gives a complete list of the compounds found in petroleum and the characteristics of oils from different fields. The organic origin of petroleum is generally conceded but entire agreement has not been reached concerning whether the organic origin is animal or vegetable. It is probably both. Natural gas generally occurs in proximity to petroleum. A.E.R.W.

Relative merits of pulverized fuel and mechanical stoking. I. W. E. WOODESON AND J. S. GANDER. *Mech. World*, **85** [2208], 392–95 (1929).—No method of burning coal approaches maximum theoretical efficiency so closely as the use of pulverized fuel. Woodeson pointed out that a cu. in. of coal pulverized correctly produces nearly 200,000,000 particles, the total superficial area of which is over 3000 sq. in. As combustion rate depends on the ease with which air has access to the coal, obviously a correctly designed burner permits practical and complete combustion with the minimum excess air. This perfect mixing of air and coal is an advantage of this system

of firing. Broadly speaking, quality is not a factor in burning pulverized coal. A poor quality of coal does not burn freely, but Woodeson has successfully burned all grades. Cleaning of fires, even with the worst coal, takes only 1 min. to 90 secs. per furnace, thus maintaining a straight-line steam pressure. The working parts are easily accessible, and may be replaced in 10 to 15 min. The burner is simple and incapable of choking, there being no small or intricate passages to choke, and no trouble whatever is experienced by overheating it. The supply of coal to any individual furnace can be controlled at will. **II.** *Ibid.*, **85** [2209], 409–10 (1929).—Compared with hand firing, maintenance costs of mechanical stoking are low, and fuel economy is effected. Other economies are smokeless combustion and regular firing which is better for all types of boilers. There are two different types of stokers, "sprinkler" and "coking." The former is able to burn any class of fuel, but the latter demands coal of a bituminous or semi-bituminous nature. The coking class is preferable where smoke abatement is imperative. The sprinkler distributes the fuel over the whole grate area to any desired thickness, generally 2 in. in a uniform manner. The fires are cleaned periodically by hand or machine motion to the bars. The coking or caking stoker usually operates by feeding the fuel either from below or by slowly advancing it from the front to the back of the furnaces. Many users of pulverized fuels find it more economical to pay a higher price for the better quality. Pulverization is not the only method of burning low-grade fuels, as a chain-grate stoker can burn any grade. One type of rotary mechanical stoker (Stein and Atkinson's) is able to consume coal refuse containing over 35% of water and 25% of ash. Where any question of freight or carriage is involved it generally pays to burn a fair grade of fuel. The chief objection to the use of pulverized fuel is the emission of fine slag of microscopic size. This is extremely harmful to both animal and plant life. E.P.R.

Low-temperature carbonization. DAVID BROWNLIE. *Gas Age-Rec.*, **63** [22], 753–54 (1929).—About 150 important low temperature carbonization processes are now in operation or under consideration. A partial list of these processes is given. F.P.H.

Carbonization of coal. ANON. *Mech. World*, **85** [2210], 429–30 (1929).—The subject of the carbonization of coal occupies a prominent place in the considerations of the engineering profession today. The writer gives an excellent summary of the engineering problems and economies involved. E.P.R.

Illinois coal. A. BEMENT. Ill. State Geol. Surv., *Bull.*, No. 56, pp. 1–110 (1929); *Econ. Geol.*, **24** [3], 338 (1929).—A nontechnical account of the occurrence, production, and preparation of Illinois coal is given. A.E.R.W.

Coal stripping. L. G. HENBEST. Ill. State Geol. Surv., *Coöp. Min. Series, Bull.*, No. 32, pp. 1–26 (1929).—The possibilities of coal stripping in Saline and Gallatin counties near Equality, Ill., are discussed. A.E.R.W.

Purchase of fuel by specification. ANON. *Brit. Clayworker*, **38** [445], 50–51 (1929).—The best results in plant practice are obtained by the use of fuel of consistent size and quality. On chain-grate stokers a higher percentage of CO_2, and also better fires and results in general are obtained, if the coal is identical in quality and size throughout any test or under ordinary working conditions. There are over 20 different sizes of dry and washed fuels at present although about 6 should suffice. The coal should be bought on an agreed calorific basis, moisture content, and size. R.A.H.

Terminology in coal research. REINHARDT THIESSEN AND WILFRID FRANCIS. Bur. Mines, *Tech. Paper*, No. 446, 27 pp. (1929).—The authors refer more particularly to the terms "vitrain," "clarain," "durain," and "fusain" recently coined in England, and to the terms "anthraxylon" and "attritus" evolved contemporaneously in America. The observations which lead to the conception of these terms are reviewed to indicate

the different angles from which the subject of coal terminology has been viewed, to show how the original definitions have had to be modified in the light of later knowledge, and to suggest how some of these terms may be interchanged or used to describe the older terms in general use, especially the German terms "Glanzkohle" and "Mattkohle."

R.A.H.

Evolution in conception and heating of continuous furnaces. A. HIRT. *Chaleur ind.*, **9**, 369–78 (1928).—The first furnaces were for baking brick; the fuel was added directly from above, as in the Hoffman continuous furnace, with but fair results. Automatic feeding was then added and this improved combustion. For fine ceramic ware special furnaces were employed with a transverse grate working at 1300°. The primary air was regulated and good combustion was obtained; but the flame followed the air and there was a tendency to clinkering. This furnace was not tight and fuel consumption and labor were high. Intermittent ceramic furnaces often utilize external semi-gas firing. Primary air enters on the furnace grate and secondary air is heated by the cooling of products and by brickwork. Such furnaces require good coal, high in volatile matter. In the Faugeron furnace secondary air is heated by arches and has a zigzag path; a low draft is required. Modern gas-fired furnaces have many advantages over coal furnaces. To bake a ton of refractory requires 500 cm. of air for the combustion of the necessary coal, and 820 cu. cm. are required for cooling off the same products. There is then an excess of air, which increases fuel costs and renders difficult the circulation of the product of combustion and produces uneven heating. H. considers better methods of heating in detail and gives temperature curves of the Hirt furnace. For furnaces requiring high temperatures recuperators may be at the walls; waste heat apparatus may be installed. There are 18 diagrams with a discussion. (*C.A.*)

BOOKS

Structure of Typical American Oil Fields. Symposium on Relation of Oil Accumulation to Structure. Vol. I. xvii + 510 pp. Amer. Assoc. Petr. Geol., Tulsa, Okla., 1929, Price $5.00. Reviewed in *Econ. Geol.*, **24** [3], 339 (1929).—A compilation of 30 papers on the structure of typical oil fields in Ark., Calif., Ind., Kans., Ky., La., Mich., N. Mex., Ohio, Okla., Tenn., Texas, and W. Va. Each article describes the dominant structure of the field with which it deals and illustrates the description with maps, sections, and production graphs. The general geology of the district in which the field is situated is outlined and the relation of the productive portion of the field to the structure is discussed. Decline curves for average wells are given and from these the ultimate yield per acre is calculated. Nearly all types of confining structures are illustrated and the relation of production to structure in each field is well shown. E.P.R.

Practical Industrial Furnace Design. M. H. MAWHINNEY. Chapman and Hall, London, 1928. Price 20*s* net. Reviewed in *Mech. World*, **85** [2209], 422 (1929).—For abstract see *Ceram. Abs.*, **8** [1], 43 (1929). E.P.R.

Oil and Gas in Western Canada. G. S. HUME. Geol. Surv. of Canada, *Econ. Geol.*, Series 5, 1928. 152 pp., 14 illus. Price 25 ¢. Reviewed in *Econ. Geol.*, **24** [3], 337 (1929).—The publication consists of a series of reports on the individual oil and gas fields now known to exist in the region extending from Manitoba on the east, to British Columbia on the west, and north to Great Slave Lake and the MacKenzie River Basin in the North West Territories. E.P.R.

PATENTS

Heat treatment and apparatus therefor. TAINE G. MCDOUGAL. U. S. 1,713,851, May 21, 1929. (1) The method of firing ceramic ware which consists in mounting the article to be treated in a kiln in position to be exposed on substantially all sides to direct radiation from the walls of the kiln and applying heat to the walls. (2) A tunnel kiln, the heating zone of which is in the form of a substantially closed tube, the tube being

provided with a narrow longitudinal slot, and a refractory support for ware substantially closing the slot and arranged to travel through the tunnel, the mass of the support being small compared with the mass of the walls of the tunnel so as to reduce the amount of heat absorbed by the traveling support.

Tunnel-kiln construction. TAINE G. MCDOUGAL. U. S. 1,713,852, May 21, 1929. In a tunnel kiln, a heating and a preheating zone, means for supplying heat to the heating zone, a muffle of refractory material within the preheating zone, means for passing ware through the preheating and heating zones, the walls of the muffle being converged toward the end adjacent the heating zone.

Portable kiln platting. CLAUD E. FULLER. U. S. 1,716,341, June 4, 1929. An improved portable kiln platting comprising a rectangular slab of refractory and insulating material, the slab being provided with a plurality of perforations extending therethrough.

Drying system for use with annular kilns. OTTO BUSCH. U. S. 1,718,190, June 18, 1929. The combination with an annular kiln of a plurality of parallel drying chambers arranged at opposite sides of the kiln, two series of flues carried transversely across the chambers one above and the other below the same, fans communicating with the different flues, and means for connecting the flues with one another and with the kiln to allow combustion gases and hot air from the kiln to be used for direct and indirect heating of the chambers and to allow the moist air from the chambers to be returned to the flues for admixture with the fresh drying air.

Feeding powdered coal to burners. BERG & CO. GES. FÜR INDUSTRIE-OFENBAU U. FEUERUNGSBEDARF M.B.H. Fr. 648,008, Jan. 31, 1928. (*C.A.*)

Ceramic furnaces. EDWARD G. SPENCER-CHURCHILL. Fr. 649,971, Feb. 27, 1928. Ceramic furnaces are arranged in a group around a common chimney and have means for passing the hot gases from one furnace to the next so that they may be used in a cycle. (*C.A.*)

Kilns. NICOLA LENGERSDORFF. Ger. 471,772, May 5, 1925. A gas-heated kiln has 2 parallel heating chambers. (*C.A.*)

Regenerative chamber kiln. C. OTTO & CO. G.M.B.H. Ger. 472,678, Mar. 15, 1927. (*C.A.*)

Loading device for annular kilns. THOMAS STÖLZLE. Ger. 473,507, Mar. 18, 1927. Details of construction are given. (*C.A.*)

Geology

Limestone resources. J. E. LAMAR. Ill. State Geol. Surv., *Rept. of Invest.*, No. 17, pp. 1–27 (1929).—L. reports the results of an investigation of the suitability of the limestone of the Pontiac-Fairbury region for industrial use. Diagrams show the relative positions of quarries and railroads. A.E.R.W.

Sands along South Atlantic coast. ANON. *Mfrs. Rec.*, **95** [24], 59 (1929).—A. F. Greaves-Walker, states that the sands along the south Atlantic coast produce a 75% concentrate which analyze 55% ilmenite, 29% zircon, 6% rutile, and 2% monozite, the monozite running about 4 to 6% thoria. While little monozite is expected from Fla., the sands of the entire east coast from St. Simons Island to Eau Gallie are rich in ilmenite, rutile, and zircon, and these tremendous reserves will some day be worked. E.P.R.

Pleistocene glaciations of the Northern hemisphere. F. LEVERETT. *Science*, **69**, 231–39 (1929).—Evidence has been found of 4 glacial stages in Europe and possibly 5 in America. The controversy is as to the relation of the Iowan drift to the 3rd or Illinoisian drift. The chief factor in bringing about glacial stages is lowering of temperature rather than increase of precipitation. H.H.S.

Platinum world production. ANON. *Chem. News*, **138**, 324 (1929).—The chief source of Pt, for which chemical industry must compete with the jewelery trade, continues to be the Urals in Russia, but noteworthy quantities are now extracted in Columbia, Canada, and S. Africa. From 1914 to 1923 the principal source for the U. S. was Columbia. The Canadian supply shows considerable annual advance. H.H.S.

Copper deposits. JANET MUNRO. *Chem. News*, **138**, 328–29 (1929); *Toronto Financial Post*, April 12.—Native copper is found in vast quantities in the Arctic Canada. The recent completion of the Hudson Bay Ry. and the development of aerial and motor transport makes the opening up of the Arctic practicable. H.H.S.

Aerial exploration. ANON. *Chem. News*, **138**, 329 (1929).—Last year 100,000 miles were flown by pilots in the service of the Northern Aerial Minerals Exploration Company. The territory covered extended from Ungaga in northern Quebec to the Yukon on the West. H.H.S.

Potash: Dead Sea concession. ANON. *Chem. and Ind.*, **48**, 519 (1929).—The British Govt., acting for the Govts. of Palestine and Transjordan, has granted (White Paper Cmd. 3326) to Tulloch and Novomeysky the exclusive rights for 25 years to extract mineral salts from the Dead Sea. The company will be required to produce 3500 T. per annum of 80% KCl during the 5th year, and 50,000 T. per annum after the 10th year. H.H.S.

Bentonite, its occurrence, properties, and uses. C. C. O'HARRA. *Black Hills Engineer*, **17**, 39–48 (1929). (*C. A.*)

A genesis of some types of feldspars from granite pegmatites. OLAF ANDERSEN. *Norsk Geol. Tids.*, **10** [No. 1–2], 116–205 (1928).—At first there was probably simultaneous crystallization of Na-K feldspar and plagioclase from a magmatic solution rich in volatile constituents, the 2 feldspars separating in individual crystals. The Na-K feldspar may have been a homogeneous variety; the plagioclase was usually a soda-rich type, sometimes pure albite. Often there was formed antiperthitic intergrowths by a rhythmical simultaneous crystallization of plagioclase and small quantities of K feldspar in parallel orientation. Exsolution, giving rise to perthite, went on at an early period and resorption and replacement phenomena may have begun to play a part. Occasionally there was a simultaneous (not eutectic) crystallization of both feldspars, the plagioclase in the few examples of this being an andesine. The second stage was characterized by a more active process of resorption and replacement. The platy variety of albite (cleavelandite) in some of the pegmatites may belong in this stage, although its recrystallization may have begun earlier. A peculiar recrystallization of the microcline along incidental mechanical cracks has been going on during this stage and probably continued into the next. Sometimes this recrystallization has involved considerable parts of the feldspar. The effect of this recrystallization has been to destroy the regular cross-twinning of the microcline, either single crystals or irregularly twinned ones being produced. A constant feature of this stage, as of the next, is the continued formation of contraction cracks. Through many of these cracks communication with the remaining magmatic solution has been established and the various fluids or gaseous emanations derived from the magmatic solution has exerted their influence on the feldspar with which they may have come in contact. At first they have had a resorbing action, dissolving principally microcline, but also to some extent albite and poikilitic inclusions of quartz. Then they have effected the recrystallization of the microcline and have been agents of a replacement by which microcline, as a rule, has been carried away to be more or less replaced by albite. The replacement at this stage has not been carried to the extreme of removing all microcline; it has been confined to the production of perthitic veins of albite. During the closing of this stage the formation of film perthite through exsolution may have begun, and this process may have con-

tinued also through the next stage. The third stage is characterized by the extensive replacement of microcline by albite, giving rise to such peculiar feldspars as the chessboard albite and to the beautiful crystals of albite growing into cavities and often covering the outside faces of microcline-perthite. This replacement process is probably only an intensified continuation of the process leading to the formation of the perthite veins. (*C.A.*)

Chemistry and Physics

Control of clay slips by the use of electrolytes. ANON. Bur. Stand., *Tech. News Bull.*, No. 145, p. 39 (1929).—The organic matter found in ball clays belongs to the class of protective colloids which also exert a peptizing action. It has been found possible within limits to control the time of setting of the cast body by adjusting the relative amounts of electrolyte and peptizing colloids. "Livering" is a condition of the slip in which it is no longer uniformly fluid but appears to have undergone localized coagulation. It was noticed that slips containing no peptizing protective colloid tend to liver on standing overnight. The addition of a small amount of tannic acid eliminated this condition in a great many instances. A number of experiments were carried out for the purpose of studying the effect of the addition of peat muck and tannic acid to a body containing no ball clay. The body composition used was 50% English china clay, 30% flint, and 20% feldspar. With 12½% sodium silicate and 12½% sodium carbonate as electrolyte and no colloid, 450 ml. were required giving an approximate time of setting of 30 min. and transverse strength of 15 lbs. / sq. in. Using peat muck as the source of peptizing protective colloid with 0.8% colloid as carbon, 390 ml. of water were required and approximate time of setting 2 hrs. with transverse strength of 28 lbs./sq. in. Using tannic acid in place of peat muck and 0.8% colloid as carbon, 400 ml. of water were required and time of setting 3 hrs. with a transverse strength of 32 lbs./sq. in. R.A.H.

Entry of solutions into ores during leaching. ANON. Bur. Mines, *Tech. Paper*, No. 441, 38 pp. (1929).—This report presents data on the rate and volume of ingress of solutions into certain ores, on the application of principles of capillarity to the penetration of rocks by liquids, and on the manner of penetration. Before the work of this study was undertaken it was thought probable that certain laws of physical behavior governed the rate of penetration, including the law of capillary rise and Poiseuille's law for the flow of liquids through orifices. If the law of capillary rise governs the ingress of solution, a prime factor that should govern the rate of penetration would then be the surface tension of the penetrating liquid; but experiments indicated that surface tension is not the governing factor, for although the surface tension has been lowered to ½ the value for water with sodium oleate the rate of penetration was practically unchanged. Poiseuille's law was also considered, but as it is a law of viscosity it is not the governing factor determining the rate of penetration. Most leaching agents are of nearly the same viscosity. Evidence has been offered to show that the solubility of the gas within the rocks in the penetrating liquid is the factor that determines the rate of ingress of solutions. The work on the rise of solutions up a tube filled with crushed ore by capillarity has brought out the fact that there is a definite relationship between the rate of rise in the column to the percentage of apparent total penetration in larger pieces of the same ore. In this connection it is interesting to note that whereas the changing of the surface tension of the liquid ascending by capillarity markedly affects the rate of rise, a change in surface tension has no appreciable effect on the rate of ingress of solutions into larger pieces. R.A.H.

Specific heats of gases at high temperatures. E. D. EASTMAN. Bur. Mines, *Tech. Paper*, No. 445, 27 pp. (1929).—A survey of the data now available in the field of specific heats of gases at high temperatures reveals numerous discrepancies in the ob-

servations and disagreements in the equations proposed to represent them. The results of a study of the major work on specific heats of gases at high temperatures are presented in this paper. A critical review of the more important individual investigations was made. Reasons are indicated for the exclusion from final consideration of certain of these researches purporting to be of high accuracy. The results of many of the remaining works are recalculated from the original data by methods that largely eliminate errors characteristic of the methods of measurement. In addition, the recalculation and graphical presentations make apparent the exact contribution of each research, limited to its own range and uninfluenced by others, and permit independent appraisal of the results. The individual series of data obtained from the work of the various observers upon the more important substances prove on graphical comparison to be mutually consistent to a gratifying degree. Equations based on them, of greater reliability than those hitherto proposed, are presented. In addition to the substances extensively studied experimentally, some are included for which few data exist but for which reliable approximations may be made with the aid of theoretical considerations. The temperature limits and estimated errors of these equations are supplied. On the side of technique the necessity in sound velocity work of adequate temperature control, and of careful study of tube correction is emphasized. The advantages, in the other methods, of measurements relative to a standard such as argon are noted, and the fact that by the use of such measurements the solution of questions concerning heat loss and equilibrium in explosions may be approached. R.A.H.

Investigations on the one-component system SiO_2. III. Stability regions of quartz, tridymite, and cristobalite. C. J. VAN NIEUWENBURG. *Rec. trav. chim.*, **48,** 402–405 (1929).—Below 1100°C the samples were heated in nichrome-wound furnaces, the temperatures being measured by means of a Pt Pt-Rh thermocouple. Up to 1300° a platinum-wound furnace was used. Above the latter temperature a carbon-resistance furnace was used, the temperatures being measured by means of a Holborn-Kurlbaum optical pyrometer. In cases where the carbon vapors obscured the vision too greatly, use was made of a molybdenum-wound furnace operated in an atmosphere of methyl alcohol. The samples of tridymite and cristobalite were prepared by mixing quartz with 1% of lithium carbonate (catalyst) by evaporating to dryness with the proper amount of solution. After treatment in the furnace the samples were washed with dilute hydrochloric acid and distilled water and dried at 60 to 70°. The specific gravity was determined by means of a pycnometer using cyclohexanone as the filling liquid. If the specific gravity was above 2.33, the presence of quartz was indicated. The results obtained show that the stability regions of the silica minerals as defined by Fenner are correct on the whole. V. N. obtained lower temperature limits for the transformations α-β-γ tridymite and α-β cristobalite. It was proved that cristobalite can never be formed by crystallization from the gaseous phase and that amorphous silica always results. Below 1300° quartz is always a transitory decomposition product of cristobalite. After several hours it is changed in turn, evidently into tridymite. Thermal dilatation experiments showed that there exists a very clear irregularity in the expansion of tridymite at temperatures ranging from 430 to 480°. There is a more or less sudden change in the volume of the powdered samples at about 450°. On the other hand, neither a very sensitive thermal analysis nor a study under the polarizing microscope showed the slightest discontinuity at 450°. Even macroscopic crystals of tridymite from Perlenhardt, ground down to a convenient thickness, failed to show any change in color between crossed nicols. Under these circumstances, V. N. leaves open the question of the fourth modification of tridymite. A.J.M.

Studies on hydrated aluminum silicates. I. The rehydration of metakaolin and the synthesis of kaolin. C. J. VAN NIEUWENBURG AND H. A. PIETERS. *Rec. trav.*

chim., **48**, 27–36 (1929). **II. The dehydration vapor-pressure of kaolin.** *Ibid.*, **48**, 406–16.—For abstract see *Ceram. Abs.*, **8** [3], 224 (1929). A. J. M.

Application of scientific methods to the stoneware tile industry. M. F. CHALAMEL. *Sci. et ind.*, No. 183, pp. 256–66 (1929).—Clays in general are discussed. A rather complete study of French clays and Westerwald (Germany) clay from the geological viewpoint is given. A new method is presented for interpreting graphically the results of chemical analyses of clays. This is used in conjunction with microscopic analyses. Physical and ceramic tests are also discussed. Fully illustrated. A.J.M.

Fitting a straight line to a series of observations. J. H. AWBERY. *Chem. News*, **138**, 316–17 (1929). (Meeting Physical Soc. May 10.)—A method is described for determining the constants in a straight line to represent a series of data. It can be carried out in one-third the time required to apply the method of least squares, it avoids the multiplications and squarings essential to that method, its decrease in accuracy is negligible, and it presents only the significant figures. H.H.S.

Ring methods for surface tension measurements. N. E. DORSEY. *Science*, **69**, 187–88 (1929).—The du Noüy tensiometer may be used for either of two distinct methods according as the maximum pull or the constant pull are measured. No satisfactory theoretical formula has yet been derived. H.H.S.

Surface tension measurement: automatic device. LECOMTE DU NOÜY. *Science*, **69**, 251–52 (1929).—In order to eliminate the personal coefficient from measurements by the du Noüy tensiometer, an electric motor is used and the lever cuts the current as soon as the ring detaches itself from the liquid. H.H.S.

Bentonite, a sodium clay. R. M. WOODMAN AND E. MCK. TAYLOR. *Chem. and Ind.*, **48T**, 121–25 (1929).—Occurrences of bentonite are described, its association with coal is noted, and its replaceable and total sodium contents are said to characterize it. The sample investigated had $p_H = 10.5$ when suspended in water. It was impermeable to water, hence it is not very practicable as a base-exchange water-softener, though it may be used for waters containing permanent hardness or Mg salts. It proved a good emulsifier for certain oils, forming the oil-in-water type of emulsion suitable for spraying plants. With cresylic acid it gave water-in-oil as well as oil-in-water emulsion. H.H.S.

Caustification of sodium carbonate by ferric oxide. XIII. Heat of solution of sodium oxide. (Expt. 1.) MOTOTARO MATSUI AND SUKEO NAKATA. *Jour. Soc. Chem. Ind.* [Japan], **32** [4], 79B–83B (1929).—The heat of solution of sodium oxide was estimated by using a constant temperature calorimeter of submarine type. The method of preparation of the sodium oxide, analysis of the sample, and the equipment used are described. The mean value obtained as a result of this experiment was 56,608.8 ± 161.1 cal. at 25°C. **XIV. Heat of solution of sodium oxide. (Expt. 2.)** MOTOTARO MATSUI AND SEIZO OKA. *Ibid.*, 83B–85B (1929).—Using more precautions, the experiment was repeated. The sample was analyzed by the gravimetric method. The mean value of the heat of solution of sodium oxide was obtained as 56,696.2 ± 71.4 cals. Sources of error were included. For **XII** see *Ceram. Abs.*, **7** [11], 787 (1928). E.J.V.

Benzidine color reaction of the Japanese acid clay. NAOTO KAMEYAMA AND SHUMPEI OKA. *Jour. Soc. Chem. Ind.* [Japan], **32** [4], 87B–89B (1929).—The nature of the oxidizing action of the Japanese acid clay itself was studied in order to get the key to the active minor constituents of the clay having this property. The first main and quick reaction is the oxidation due to an oxidizing agent present in the clay and extractable with hydrochloric acid. The second minor and slow reaction is the slow catalytic oxidation due to the atmospheric oxygen in presence of the clay. E.J.V.

Synthesis of a substance having properties analagous to the Japanese acid clay. II. NAOTO KAMEYAMA AND SHUMPEI OKA. *Jour. Soc. Chem. Ind.* [Japan], **32** [4], 99B–

101B (1929).—A substance having qualitatively all the known properties of the Japanese acid clay was obtained. The most of these properties are due to colloidal silica, and addition of alumina strengthens the acidic properties; manganese dioxide gives the product the oxidizing property; alkali strengthens the color-taking property toward methyl violet and gives the coloration keeping property for the benzidine test. This artificial material is inferior to the natural acid clay in some of the properties, but improvement is possible with the improvement of the method of preparation. E.J.V.

System: cryolite-barium fluoride. NAOTO KAMEYAMA AND EIICHI MASUDA. *Ceram. Ind.*, **12** [6], 641 (1929).—The freezing point and eutectics of the binary mixtures of cryolite and barium fluoride were determined by means of cooling curves. For the cooling curve determination, 40 g. of the mixture was taken in one of the platinum tubes, one 15 mm. of diameter and 95 mm. of height, the other 20.5 mm. of diameter and 70.5 mm. of height. The end of thermo-element was put in the salt directly. The results obtained are as follows:

Composition of mixture BaF_2 in the mixture by weight	By mol. ratio	Beginning of freezing, °C	Eutectic point
0	0 (cryolite)	1014	
20	23.0	982	819.5
40	44.4	931	830
55	59.4	877	837
61	65.2	844	834
64	68.1	840	835
67.5	71.3	856	835
70	73.6	875	833
77.5	80.5	944	828
85	87.2	1025	820
100	0 (BaF_2)	1324	

The result shows that there is a eutectic point 835, the eutectic mixture is composed of barium fluoride 62.5% by weight, or by molecular proportion nearly exactly $BaF_2/Na_2AlF_6 = 2/1$. No compound was found. F.P.H.

Thomas Young centenary. ANON. *Chem. and Ind.*, **48**, 480 (1929).—The discoverer of "Young's modulus" of elasticity died May 10, 1829. Born in 1773, his profession medical, he has become known as the father of physiological optics through his work on ocular accommodation. H.H.S.

Humphry Davy centenary. ANON. *Chem. and Ind.*, **48**, 442 (1929).—Traveling on the Continent alone and broken in health, the greatest chemist that England has known died at Geneva on May 29, 1829. Davy discovered the elements potassium, chlorine and iodine, the electro-chemical theory, investigations on flame and combustion, and the safety lamp. He taught the mechanical theory of heat before Joule, founded the Royal Institution, and interested agriculturists in the study of science. H.H.S.

New books on chemistry and industry. ANON. *Chem. and Ind.*, **48**, 441 (1929).—The spring review number of books published in English, French, German, and Italian includes: (*a*) reviews of 41 books, among them, Westman's bulletin on the thermal expansion of fireclay brick; (*b*) a classified list of books reviewed during the last six months; and (*c*) new and forthcoming books of the leading English and American publishers. There are also articles on the reviewing of books and on the acquisition and arrangement of a chemical library. H.H.S.

Novel self-recording apparatus for determination of the expansion of solids. WILLI M. COHN. Kaiser Wilhelm Inst. Silikatforschung Berlin-Dahlem. *Z. tech. Physik*, **10**, 103–106 (1929).—The apparatus of Braun (*C. A.*, **21**, 343) for the determination of thermal expansion was provided with a photographic recording device. By a suitable use of prisms and a mirror on the galvanometer, which registers the temperature of the

object, direct photographic curves of expansion vs. temperature can be determined in a range up to 800°. The apparatus is described in detail with photographs. (*C.A.*)

Concentration of hydrogen ions in ceramic materials. JOSEF ROBITSCHEK. *Chem. Obzor.*, **4**, 5–9 (1929).—The properties of ceramic materials depend in no small degree on H-ion concentration of H_2O used for their manufacture. The experiments performed with various clays showed that the maximum strength of ceramic materials made from clays with high content of Al_2O_3 was obtained at $p_H = 7$. No effect of change of p_H, however, was observed with clays poor in Al_2O_3 and rich in SiO_2. (*C.A.*)

Determination of water in micas. K. I. VISKONT AND I. P. ALIMARIN. *Trans. Inst. Econ. Mineral Met.* [Moscow], No. 40, 18 pp. (1928).—Considerable difficulty has been encountered in the determination of H in silicates, like the micas, which retain the combined H very persistently even at high temperature and because some of the H is likely to be evolved as such by the oxidation of FeO to Fe_2O_3 by H_2O at the high temperature. These difficulties can be overcome, however, and the method of Penfield used to advantage if the substance is placed in a Pt boat together with some Pt black, some PbO and some dry Na_2WO_4 powder. (*C.A.*)

Abnormal properties of eutectics of high dispersion. N. V. AGEEV, S. A. POGODIN, AND N. S. KURNAKOV. *Ann. inst. anal. phys.-chim.* [Leningrad], **4**, 23–38 (1928).—This article is a study of the effect of dispersion upon electrical conductivity, hardness, and coefficient of linear expansion in a eutectic mixture. Alloys of Sn with Pb, and of Ag with Cu were selected for study. The Brinell hardness tester was used. The increase in hardness of quickly chilled, as compared with slowly cooled samples is much greater for a eutectic alloy than for one of any other composition. The abnormal behavior of a eutectic mixture is noticeable also on the diagrams of specific conductance and thermal coefficient of electrical conductivity. When the alloys are annealed the difference between the slowly, and the quickly chilled alloys disappears. (*C.A.*)

Eutectic areas. W. WAHL. *III. Nord. Kemistmötet* [Finland] pp. 180–83 (1928).—A eutectic point appears in a quaternary system only in case all 4 components in crystallized forms are insoluble in each other. If 2 compounds build mixed crystals in all proportions and these are insoluble in each other a eutectic line is obtained. If 3 of the components form mixed crystals but the 4th is insoluble in these, a eutectic area is obtained, which is defined by the 3 eutectic points and the 3 tertiary eutectic lines for the system. Likewise a eutectic area is obtained if the 4 components, pair for pair, form mixed crystals in all proportions, but these mixed-crystal series are not soluble in each other in crystalline form. The eutectic area in such a system takes in the 4 binary eutectic points and the 4 eutectic lines. The four-component system, naphthalene-β-naphthol-azobenzene-stilbene has been studied. In it the two binary systems, naphthalene-β-naphthol and azobenzene-stilbene form mixed crystals which are insoluble in each other. A diagram of the results obtained together with a discussion is given. A number of natural products (rocks) are considered from the point of view of being four-component systems of the type investigated. (*C.A.*)

Influence of cooling velocity upon eutectic structure. G. TAMMANN AND A. A. BOTSCHWAR. Univ. Göttingen. *Z. anorg. allgem. Chem.*, **178**, 325–28 (1929).—With very slow cooling it is possible to effect a considerable separation of the two constituents of a eutectic through crystallization, especially if one is much heavier than the other. Slow cooling leads to large crystals in the eutectic. Centrifuging a very slowly crystallizing eutectic results in a very considerable separation. Eutectic compositions of the binary systems Bi-Sn, Bi-Pb, Bi-Cd, Pb-Sb, and Sn-Pb were treated in this way. The liquid eutectic was placed in a furnace the temperature of which was 2 to 3° below the eutectic temperature. Upon attainment of the eutectic temperature the alloy was cooled 2° during 2 to 6 hrs. The quantity of metal used was 40 to 50 g. The separation

of eutectic graphite in Fe-C alloys (C 3.90, Si 2.72, Mn 0.45, P 0.28, S 0.07%) is similar, but it is necessary first to break up the graphite dendrites which form a skeleton throughout the melt supporting itself in the melt. The structure of these eutectic alloys is illustrated by six photomicrographs. Similar separation in eutectic mixtures is found among igneous rocks, where the rate of cooling was very slow. Here the grains are almost always very large. (*C.A.*)

BOOKS

History of Physics. FLORIAN CAJORI. Revised ed., 424 pp. Macmillan & Co., New York, 1929. Price $3.50.—The new edition carries over 100 pp. of new material descriptive of recent progress. H.H.S.

Reference Book of Inorganic Chemistry. W. M. LATIMER AND J. H. HILDEBRAND. 442 pp. Macmillan & Co., New York, 1929. Price $3.75.—Chemical properties as related to the periodic system, atomic structure, ionic sizes, theories of valence, and the newer developments in quantum theory are discussed. H.H.S.

A Concise Summary of Elementary Organic Chemistry. F. H. CONSTABLE. Methuen and Co., Ltd., London, 1929. Price 4*s* 6*d* net. Reviewed in *Mech. World*, **85** [2210], 438 (1929).—A condensed summary is presented of the chemistry of the carbon elements or compounds, and of such a type as is found extremely useful by candidates preparing for entrance examinations of the open scholarship type to the universities. The plan of the book is that of giving a list of the reactions common to a set of compounds, and afterward studying the application of these tests to definite examples. E.P.R.

Evolution of the Igneous Rocks. N. L. BOWEN. Princeton Univ. Press, 1928. Pp. x + 332.—The following subjects are presented: the problem of diversity of igneous rocks, liquid immiscibility in silicate magmas, fractional crystallization, crystallization in silicate systems, the reaction principle, fractional crystallization of basaltic magma, the liquid lines of descent and variation diagrams, the glassy rocks, rocks whose composition is determined by crystal sorting, effects of assimilation, formation of magmatic liquid very rich in potash feldspar, alkaline rocks, lamprophyres and related rocks, fractional resorption of complex minerals and formation of strongly femic alkaline rocks, further effects of fractional resorption, importance of volatile constituents, petrogenesis and the physics of the earth, classification of igneous rocks. Reviewed in *Eng. Min. Jour.*, **127**, 206 (1929). A.J.M.

Introduction to Crystal Analysis. WILLIAM BRAGG. D. Van Nostrand, Inc., New York. Price $4.25.—The book is founded on a course of lectures intended for a general audience. The test, however, has been amplified and the book serves as a guide to students or those who desire to understand the main principles of this new subject. B. expresses the hope that he has illustrated the powers of his subject in such a way that the average reader may secure some idea of the direction in which this work is advancing and may be able to forecast future applications. Reviewed in *Can. Chem. Met.*, **13** [5], 82 (1929). E.J.V.

Salts, Acids and Bases: Electrolytes: Stereochemistry. PAUL WALDEN. McGraw-Hill Book Co., New York, 1929. Price $4.00.—Lectures delivered at Cornell, the fourth in the series of George Fisher Baker non-resident lectureships are given. H.H.S.

Laboratory Investigation of Ores. Edited by E. E. FAIRBANKS. McGraw-Hill Book Co., New York, 1928, 262 pp., 91 figs., Price $3.50. Reviewed in *Econ. Geol.*, **24** [2], 216 (1929).—The range of subjects covered in this book may be seen by the following list of chapters and authors: Historical Review of Study of Polished Specimens, by W. Lindgren; Microscopes, Dielectric Methods, and Zonal Distribution by E. E. Fairbanks; Crystal Analysis by X-Ray by W. P. Davey; Practical Photomicrography by R. P. Loveland and A. P. H. Trivelli; Genetic Significance of Grain by

A. C. Lane; Ore Mineral Sequence by R. J. Colony; Microscopic Criteria of Replacement by W. H. Newhouse; Textural Relationships of Opaque Manganese Minerals by G. A. Thiel; Geologic Thermometry by N. L. Bowen; Enrichment of Silver Ores by F. M. Guild; Ore Dressing Microscopy by G. M. Schwartz. The book is not suitable as a textbook for those who are first taking up the study of polished surfaces of ores, but will serve as a valuable reference book for those already acquainted with the subject. E.P.R.

Elementary Applications of Statistical Method. H. BANISTER. Blackie & Son, Ltd., London, 1929. Price 3*s* 6*d*.—The application and comprehension of statistical data are discussed. H.H.S.

PATENT

Alkaline-earth titanates. E. C. R. MARKS. Brit. 308,516, May 15, 1929. Alkaline-earth titanates, *i.e.*, barium titanate, for use particularly as pigments, are produced by heating precipitated titanium hydrate free from sulphate with alkaline earth metal carbonates in the presence of an accelerator such as hydrochloric acid or an alkaline-earth metal chloride. Temperatures of 750 to 880°C suffice for the reaction, and the proportions used may be such that the titanate produced is slightly alkaline. The titanium hydrate used may be freed from sulphate by treatment with a normal acetate of zinc, an alkali metal, or ammonium, followed by washing with water.

General

Lubricating high temperature conveyers. ANON. *Arch & Bldg.*, **61** [4], 129–30 (1929).—One of the most difficult lubricating problems confronting the engineer is that of properly lubricating conveyers that operate in heaters, kilns, core ovens, enameling ovens, etc. There is no "perfect" oil for the purpose. The oil commonly used has a high flash test and a high fire test of over 600°F. Though the temperature is no higher than 400 to 500°F, a considerable bituminous and tarry matter is deposited and the deposit eventually clogs up the bearings, the pins in the chain, and the parts refuse to move, resulting in damage to the mechanism. Oil which does not possess a high flash point is better. When it evaporates or chars down it will leave only a small amount of residue, not tarry but dry and fine, very much like graphite. E.P.R.

Artificial drying of buildings. ANON. *Arch. & Bldg.*, **61** [3], 98 (1929).— A machine manufactured by Deuba Building Drying Corporation (Hanover, Germany) is set up outside of the building, heats the air by means of a coke fire, burning from 60 to 80 lbs. of coke per hr. The heated air is driven by a blower through pipes into the building. The temperature of the air blast can be varied from 60 to 200°F. With a battery of these machines, it is possible to dry out a large building within 3 or 4 days. This apparatus should be a distinct improvement over the commonly used salamanders and should also offer great possibilities for maintaining temperature in concrete buildings during winter construction. E.P.R.

Significance of boiler leakages. EDWARD INGHAM. *Mech. World*, **85** [2210], 436–37 (1929).—A leakage from a steam boiler may be a matter of trifling importance; it may, on the other hand, be an indication of serious danger. I. discussed this in detail. E.P.R.

Economy of transporting gas by the tapered pipe line. LLOYD T. JONES. *Gas Age-Rec.*, **63** [22], 746–50 (1929).—J. makes a comparative study of the characteristics of two types of pipe line, (1) the cylindrical line of uniform diameter and (2) the tapered line which increases in diameter as the line proceeds. The comparison is made on the basis of equality of cost of construction of the two types of line. F.P.H.

Pulverized coal on gas-fired boilers. A. E. DURAM. *Blast Fur. Steel Plant*, **17** [6], 882–83 (1929).—Recent improvements in furnace design by the control of dust and

slagging result in high efficiency. Quick response and low operating cost make it an ideal supplementary fuel. F.P.H.

Modern use of pulverized fuel in power-stations. R. A. CHATTOCK. *Mech. World*, **85** [2207], 371–73 (1929).—Some five years ago the use of pulverized fuel in electric power-stations was being developed on a large scale in the U. S. The installation at Prince's Station, Nechells, is shown diagrammatically and consists of 6 Vickers-Spearing water-tube boilers, each having a heating surface of 5400 sq. ft., four of them being fitted with economizers and two with air-heaters. The normal evaporative capacity of these boilers is 35,000 lb. of steam per hr. (actual), the overload capacity being 42,000 lb. of steam per hr. (actual). The Lopulco pulverized-fuel system was adopted. The cooling effect of the brickwork of the air that passed through the hollow combustion chamber walls was not sufficient to allow the CO_2 content to be raised higher than 14%, with a result that the thermal efficiency was low. The steam-operated coal driers also proved inadequate, making necessary selection of coals, carrying not more than 15% of moisture. With a percentage higher than 10% moisture, difficulties are experienced with packing in the Fuller-Kinyon pumps, in the pulverized-fuel bins over the boilers, and in the screw feeders to the burners. E.P.R.

Effect of air-drying during pulverization. ANON. *Pit and Quarry*, **18** [1], 89 (1929).—The results obtained prove the practicability of drying materials during the pulverizing process. R.G.E.

Hazards of material handling. H. W. GABOR. *Rock Prod.*, **32** [10], 97–100 (1929). F.P.H.

Scientific management of lime plants executed upon the basis of time studies. CARL LANGE. *Tonind. Ztg.*, **52** [76], 1532–34 (1928); *Rock Prod.*, **32** [11], 84 (1929). F.P.H.

Removal of fumes and dust in chemical factories. H. REININGER. *Chem. Fabrik.*, **18,** 205–207; **19,** 230–32; **22,** 271–73 (1929).—Construction features as shapes of roofs and roof trusses, exhausters, etc., are discussed and illustrated in the first two parts while the last part contains a brief discussion of chemical air purification. T.W.G.

Special type stripping machine. ANON. *Pit and Quarry*, **18** [1], 50 (1929).—The France Quarries, of Toledo, have reduced the hauling expense to a minimum by excavating the overburden by the usual steam shovel and then dumping immediately into a worked-out quarry bottom by means of a long portable belt conveyer called a stacker. This conveyer follows the stripping shovel and reaches to a point in the quarry beyond the path of the main excavating shovel and the quarry cars. R.G.E.

Why air receivers explode. RICHARD H. BRITT. *Rock Prod.*, **32** [10], 111–12 (1929). F.P.H.

Prevention of accidents. T. J. QUIGLEY. *Pit and Quarry*, **18** [1], 65–66 (1929).—Statistics of the Department of Labor and Industry prove that 75% of all accidents that occur in industry are preventable. The prevention of this 75% of the accidents is entirely in the hands of the men themselves. Three-fourths of all accidents are caused by negligence, carelessness, and disobedience, and no amount of money can eliminate these factors. One does not have to invest money to accomplish real accident prevention results. Use of the personnel (plant manager, superintendent, and foreman) is recommended, and if they render 100% service, accidents will decrease and dividends and production increase. R.G.E.

New type of explosive in quarrying industry. ANON. *Pit and Quarry*, **18** [1], 61–62 (1929).—Considerable attention is being given to the adaptability of liquid oxygen in quarrying. It is now being used successfully in several mid-western states. Loxite is a perfected liquid oxygen explosive and consists of a cartridge made up of various carbonaceous materials soaked in liquid oxygen. These are detonated by Cordeau-Bickford

safety fuses or by special electric blasting caps. Users of this explosive emphasize the following advantages over dynamite: (1) better primary fragmentation, (2) less secondary blasting, (3) increased shovel efficiency, (4) substantial direct savings, (5) no danger incident to digging into missed holes, and (6) no storage hazard. While no explosive can be said to be the best for all operations and conditions, Loxite, due to its efficiency and lower cost, and especially its many inherent safety features, has undoubtedly come to stay and promises to be increasingly used as a blasting agent in the open-pit and quarry field. R.G.E.

Safety methods in handling and using explosives. H. M. HAMILTON. *Pit and Quarry*, **18** [1], 75 (1929).—Precautions to be observed for best results in loading holes, tamping, firing, and storage are given. R.G.E.

Digging clay. ANON. *Brick Clay Rec.*, **74** [13], 867 (1929).—A Nordberg-Butler underground air-operated shovel used for loading clay at the Hydraulic Press Brick Co. plant at Brazil, Ind., is operated at a total cost of about 16¢ a ton. Beside the direct saving over hand loading some invisible savings accounted for are (1) fewer openings in the mine, (2) fewer operators reducing insurance, overhead, and supervision costs, and (3) a more accurate control of daily tonnage. E.J.V.

Faulty factory illumination, an industrial hazard. ANON. *Abrasive Ind.*, **10** [5], 33–34 (1929).—It is pointed out that thousands of cases of seriously defective vision would be prevented by correcting faulty lighting facilities. The article concludes by stating that it is a wise policy for any industrial establishment of reasonable size to obtain simple instruments for light measurement and at regular intervals to check the lighting efficiency. E.P.R.

Marking imported glassware. ANON. *Pottery Gaz.*, **54** [624], 934–50 (1929); for abstract see *Ceram. Abs.*, **8** [6], 461 (1929). E.J.V.

Production and distribution of power in works. ANON. *Chem. and Ind.*, **48S**, 1–24 (1929).—Summarizes the trade literature of eighty firms, and indexes them under the headings: steam production, steam conveyance, use of steam for power, use of steam for heating, gas production and use, internal combustion engines, hydraulic power, distribution of mechanical power, electric generation, electric distribution, compressed air and vacua, heating and drying, lubricating, and sundries. H.H.S.

Economics of plant location. C. H. SONNTAG. *Pit and Quarry*, **18** [1], 83–86 (1929).—S. gives a systematic presentation of the factors involved when a new enterprise in the nonmetallic field is under consideration. Detailed discussions under the following headings are given: (1) market, (2) raw materials, (3) transportation, (4) fuel, (5) water supply, (6) power, and (7) labor. R.G.E.

New research laboratories. ANON. *Glass Ind.*, **10** [6], 136–38 (1929).—An illustrated detailed description is given of the new research laboratories of the Glass Container Assn., 39 West Thirty-eighth St., New York City. Some of the activities of the organization are discussed. E.J.V.

American Association for Advancement of Science. ANON. *Science*, **69**, 107–30 (1929).—Accounts of the sessions of the Sections A to Q and of associated and invited organizations of the 5th N. Y. meeting of the A.A.A.S. are given. The attendance at Section E (Geology) constituted a record (800), since the Geological Society of America and its affiliated societies met with the A.A.A.S. A notable feature of Section C (Chemistry) was a joint session with Section K (Economics) on the subject of economics and chemical progress. H.H.S.

Research in engineering and its financial support. A. N. TALBOT. *Science*, **69**, 171–75 (1929).—The vice-presidential address to Section M (Engineering) at the New York meeting of the A.A.A.S. is given. Research is classified into two groups, research

that is directly related to financial interests, and research of general advantage to the public. The agencies of research and its financial support are described. H.H.S.

Ceramic industries in Iowa. PAUL E. COX. *Clay-Worker*, **91** [6], 496–98 (1929).—Iowa heads the list of states in the production of common drain tile. Iowa has no refractory clays suitable for firebrick manufacture, but there are raw materials to be had for terra cotta manufacture and for the production of buff face brick and light-colored building units. Iowa is favorably situated for the shipping in of clays for making white ware. Sanitary ware can be made from domestic clays. Iowa coal is too high in sulphur for use in the production of high-grade ceramic products. Work has been done to determine the suitability of this coal for use in clay products manufacture. The chief problem of the Iowa ceramist is not clay or other materials of that sort but the fuel and its quality. E.J.V.

British ceramists visit America. ANON. *Bull. Amer. Ceram. Soc.*, **8** [6], 143–78 (1929); *Brick Clay Rec.*, **74** [11], 732–33 (1929).—A brief illustrated report of the British ceramic tour in America. E.J.V.

Federal trade practice conference. II. The Face Brick Conference. WILLIAM C. KOCH. *Clay-Worker*, **91** [6], 492–94 (1929); see *Ceram Abs.*, **8** [7], 540 (1929). E.J.V.

Paving Brick Institute. ANON. *Clay-Worker*, **91** [7], 598 (1929).—A group of men representing the plant operators of the Natl. Paving Brick Assn. were organized into the Paving Brick Institute at Roseville, Ohio, on May 24. This organization was stimulated by the realization of the availability of the Roseville Station for research and plant proving. E.J.V.

Summer meeting Ohio Ceramic Industries Association. ANON. *Clay-Worker*, **91** [7], 590 (1929).—A two day meeting was held at the Zanesville Country Club, starting June 28, with a program of modern marketing methods and plant management. Plant visits are included in the plans. E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **54** [624], 923–33 (1929).—A report is given of the May meetings at which the following papers were presented: "A Study of the Thermal Expansion of Glass up to the Softening Point," by W. E. S. Turner and F. Winks; "A Particular Method of Measuring the Viscosity of Glass at High Temperatures," by R. F. Proctor and R. W. Douglas; "The Photo-elastic Properties of Glass," by F. C. Harris; and "The Glass Industry in North America," by W. E. S. Turner. E.J.V.

New association formed in Wisconsin. ANON. *Brick Clay Rec.*, **74** [11], 736–37 (1929).—The Wisconsin clay manufacturers organized the Wisconsin Clay Products Assn. at a meeting held at Madison on May 8. An ambitious program has been adopted which includes the establishment of a Fellowship in Ceramics at the University of Wisconsin, and other efforts of coöperation and merchandising. E.J.V.

Iowa State College ceramic show. ANON. *Bull. Amer. Ceram. Soc.*, **8** [7], 185 (1929); *Clay-Worker*, **91** [7], 582–83 (1929).—An account of the show given to inform the Iowa public of the scope of the ceramic profession. Exhibitions sent in by alumni became permanent parts of the department museum. The various exhibits and displays are described. E.J.V.

North-East Coast Exhibition. ANON. *Pottery Gaz.*, **54** [624], 951–53 (1929).—A description is given of the pottery and glassware exhibits at the great North-East Coast Exhibition at Newcastle, which has been inaugurated to promote the trade and commerce of the North. E.J.V.

Abrasive display. ANON. *Abrasive Ind.*, **10** [5], 40 (1929).—The exhibition of foundry equipment and supplies held in Chicago, April, 1929, in connection with the Thirty-third Annual Convention of the American Foundrymen's Assn., contained inter-

esting features. Over 150 manufacturers showed equipment and at many of the booths recently developed equipment was displayed for the first time. E.P.R.

Machine tool show. ANON. *Abrasive Ind.*, **10** [6], 20 (1929).—The machine tool show, the second national exposition held under the management of the National Machine Tool Builders' Assn., will be in Cleveland, Sept. 30 to Oct. 4, 1929, inclusive, occupying somewhat more area than the first of the shows held in the same Public Auditorium building unit in the same city, in 1927. About 230 exhibiting companies are listed. E.P.R.

To advertise paving brick. ANON. *Brick Clay Rec.*, **74** [13], 876 (1929).—With a big merchandising job confronting them, paving brick manufacturers assessed themselves $1.50 per thousand and they will spend approximately $350,000 for national advertising in newspapers and other media. E.J.V.

The machine age. MAGNUS W. ALEXANDER. *Abrasive Ind.*, **10** [5], 29–30 (1929).—Machine methods are but an expression of man at this age, reflecting his mastery of the material world, enabling him to free himself from burdensome toil and to address himself with more leisure to things of the spirit. This is the viewpoint taken by the president of the national industrial conference board, trained in business administration, and an experienced observer of trends and developments in basic industries. (Address before the Ohio Chamber of Commerce, Columbus, Ohio, March 23.) E.P.R.

BOOKS

Strain Energy Methods of Stress Analysis. A. J. S. PIPPARD. Longmans Green, London, 1928. Price 14*s* net. Reviewed in *Mech. World*, **85** [2210], 438 (1929). From an examination of the general principles P. discusses their application to curved beams and stiff-jointed frames, and later to redundant structures. The second half of this volume forms a series of fully worked-out cases of structures and aeroplane frameworks; the last chapter forms an extended examination of the stresses in a flywheel in contrast to the usual elementary treatment which neglects the rigidity supplied by the arm connections. E.P.R.

Principles of Valuation. J. A. GRIMES AND W. H. CRAIGUE. Prentice-Hall, Inc., cloth, 274 pp., issued by *Abrasive Ind.*, Price $10.00. Reviewed in *Abrasive Ind.*, **10** [5], 41 (1929).—The objective of this book is the development and comparison of the several mathematical principles which are adapted to the valuation of future income, and a discussion of these principles with respect to their applicability or inapplicability to commercial usage. E.P.R.

Hydro-Extractors. INTERNATIONAL LABOR OFFICE. Studies and Reports, Series F, No. 3, Geneva. P. S. King & Son, London, 1929. Price 4*s*.—A monograph on the prevention of accidents issued by that branch of the League of Nations concerned with social and industrial welfare. The coöperation of a number of governments has been secured to augment the usual channels of inquiry. Reviewed in *Chem. News*, **138**, 319 (1929). H.H.S.

Strength of Materials. J. O. DRAFFIN. Chapman and Halle, London, 1928. Price 15*s* net. Reviewed in *Mech. World*, **85** [2209], 422 (1929). E.P.R.

Public Schools and the Worker in New York. Natl. Indus. Conference Board, N. Y., cloth, 80 pp., issued by *Abrasive Ind.*, Price $1.50. Reviewed in *Abrasive Ind.*, **10** [5], 41 (1929).—A survey of public educational opportunities for the industrial work in N. Y. is presented in this volume. E.P.R.

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Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 — *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS

Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*

Founded 1927 — *Head of Department:* JOHN N. FRANK

UNIVERSITY OF ALABAMA

UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

Curriculum—Technical ceramic courses given by Dept. of Chemistry and Metallurgy

TWO INSTRUCTORS — *Director:* STEWART J. LLOYD *Ceramics:* T. N. MCVAY

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MARION FOSDICK, J. E. HANSEN, W. V. KNOWLES	Art, Enamel	J. T. LITTLETON, G. W. MOREY, E. H. VAN SCHOICK, DOROTHY A. TEXTER, R. F. SHERWOOD, E. H. FRITZ	Glass, Refractories, White Wares	SAMUEL J. MCDOWELL, H. D. CALLAHAN	Terra Cotta
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Vol. 8 **August, 1929** **No. 8**

EDITORIAL

EDUCATION FOR ENAMEL TECHNOLOGISTS[1]

The Report of this Committee last year contained a definite proposal for a system of ceramic education in which all ceramic students would take about 85% of their work in common and devote the other 15% of their time to specialized studies in the technology of either clay products, enameled metals, or glass. These specialized studies were to be taken in the junior and senior years of a regular four-year college course. The Report emphasized the belief of the Committee that in order to be prepared to win eventual promotion to the higher executive positions in the industries, students should not only receive training in scientific and technical subjects but also should be given certain courses in the fundamentals of business and a fairly large proportion of cultural subjects.

That Report was duly approved by the Enamel Division and referred to the Committee on Education of the SOCIETY for further action.[2] The

[1] Report of the Committee on Education, Annual Meeting, AMERICAN CERAMIC SOCIETY, Chicago, Ill., February, 1929. (Enamel Division.)

[2] *Bull. Amer. Ceram. Soc.*, **7** [7], 190 (1928); discussion by H. F. Staley, *ibid.*, **7** [11], 319 (1929).

Report was submitted by the general committee to the heads of the various ceramic departments in this country and Canada for their comments.

Letters of comments have been received from fourteen ceramic schools. Some of the comments were complimentary, which was pleasant, but others were highly critical, which was to be expected.

The letters have one striking characteristic in common. They show conclusively that every ceramic department in the country is earnestly striving to give its students the very best education possible. Any mistakes that are being made are mistakes of the head and not of the heart. This is as it should be. The college authorities are practically dictators of their own curricula. The students coming to the colleges, and in general the parents sending them, are not in a position to criticize a curriculum; and in fact would receive scant consideration if they attempted to do so. Partly by necessity, but mostly through trust in their instructors the students pursue the curriculum of the school they happen to be attending with faith, although it may be hesitant at times, that they are receiving the best possible training for success in life.

Our colleges, moreover, are dealing with precious material, the lives of highly selected men. Each college graduate may be said to be a man in a thousand, a man who normally should become a leader in any industry he enters. If as a class, the graduates of our ceramic schools do not become the real leaders in the ceramic industries, a grave responsibility rests on the shoulders of the men responsible for their education.

The comments of the heads of the various departments may be summarized as follows:

(1) The present curricula of the various ceramic schools are fundamental in nature. Therefore, with or without the addition of a small amount of work in enamel working, they are or should be satisfactory for the training of enamel technologists.

(2) The enameling industries are not sufficiently large to justify a special course of instruction.

(3) Possibly men for the enameling industries should receive their training in schools other than ceramic schools.

The Committee wishes to discuss each of these proposals briefly.

The technical work in a dry- or wet-coat cast-iron enameling plant consists only in part in control of the enamel. Of much more importance is control of the iron mixture, cupola practice, sand mixture, pattern design, and general foundry practice. The methods used in sandblasting and finishing the castings also call for considerable technical understanding or its equivalent in practical experience. The cleaning department is usually operated as an adjunct of the foundry. Foundry and cleaning practice are so important that it is an axiom in the industry that if the

castings are made right and cleaned right almost any one can do the enameling. In fact, there are several large plants now operating so successfully in their foundry and cleaning departments that their enameling departments are doing very well with practically no technical supervision. On the other hand, with poor foundry practice the most skillful enameler can not make a good showing.

For these reasons and because the foundry department is the largest department in the plant, the foundry dominates the enameling shop and the position of enamel department foreman or superintendent is not always a happy one. Even lower down in the scale of importance are the men who are simply enamel mixers or enamel chemists. In those large plants the number of men working in the enameling department will vary from fifty to several hundred. They are a highly paid and cantankerous lot, and unless the enamel chemist has ability to control men he cannot rise even to the position of enameling room superintendent. It has been a rather remarkable achievement for men without training in chemistry or physics to become competent enamel mixers. In their cases it shows the possession of brains and initiative. For college graduates to be satisfied with the same achievement is quite another matter.

About the only difference in the sheet metal enameling industry is that the base metal is purchased. Technical control of the quality of the sheets, methods of drawing or forming, design of shapes, scaling, and cleaning are just as important as making the enamel. In this case also the enamel maker cannot get very far unless he can control men.

In some plants the technical control work is segregated from the operating departments and conducted in what is known as the laboratory or research laboratory. These laboratories vary from purely analytical chemical laboratories to rather elaborate research departments. The staff leads a rather sheltered life, being directly responsible neither for production nor for control of labor. Consequently the pay is rather poor, for in the enameling industries, as in all others, high pay goes with responsibility. The heads of the larger research departments are really executives as well as technical men and are well paid. The individual workers do not fare so well.

From the foregoing description of the internal organization of enameling plants it is evident that a man who is simply a ceramist, or a ceramist with some training in enamel making, is not prepared to be even a good technical man in an enameling plant. He lacks training in foundry practice, metallurgy, and metallography, and these are fundamental to all technical work in enameling plants, even to control of the enameling operations. Without a knowledge of these, a man is simply groping in the dark if he tries to do technical work in an enameling plant. Therefore, with regard to preparing men for technical work in the enameling industries, the present

curricula of the various ceramic schools are not fundamental and are entirely unsatisfactory for the training of enamel technologists.

We have pointed out that in order to become a superintendent of even a department in a large enameling plant, a man must be able to control men. In this respect also the present curricula of the ceramic schools are defective, for they include as required courses neither management of labor, practical psychology, nor cultural subjects. Instead the ceramic schools send their men out with such an exaggerated idea of the importance of technical information that they unconsciously assume an air of superiority toward working men. They lack appreciation of the value of a man as a human being, which is one of the mellowing influences of the study of good literature and other cultural subjects formerly appropriately called "the humanities." Consequently as a class they make poor foremen and superintendents.

The higher executives such as plant managers and general managers of the business are chosen for their ability to manage men, or their business ability, or the combination of these attributes. Such abilities must be based on an understanding of human nature, an understanding of the fundamentals of business, versatility of mind, and wide vision. Not only do the present ceramic curricula give no training to develop these attributes, but, what is worse, by their inordinate magnification of the importance of technical work they lead their graduates to think that technical work is the all-important thing in the ceramic industries and to hold a minor technical job is a mighty fine thing. Therefore, many of the graduates do not even have an ambition to become a major executive. They have been trained for technical jobs and are satisfied to hold them. They may have a hazy hope that this may lead to being made general manager of the business, but they have no understanding of how a man gets to be a general manager and no driving ambition to become one.

Whether the enameling industries are sufficiently large compared to the other ceramic industries to justify a special course of instruction depends on whether we are talking about number of plants or the number of first-class jobs available. For the purpose of estimating the potential market for ceramic technologists, what is the use of talking about 2417 clay products plants in this country if over twenty-two hundred of them are small units? If a ceramic plant does not have an annual output of at least one million dollars it is not worth the consideration of a first-class man as a place for permanent service.

The enameling industries are rapidly becoming businesses of large units. Aside from jobbing and specialty plants, practically all the enameling in this country is done in large plants. Under present conditions the smallest plant commercially feasible for the manufacture of enameled cast-iron sanitary ware costs a million dollars, and there are several plants in opera-

tion that cost four or five times that amount. The same condition exists in the enameled cooking ware industry, in the enameled table-top industry, in the enameled refrigerator lining industry, and in the enameled sign industry. With the universal use of vitreous enamel on stoves, that industry, from the standpoint of technology, has become one of the enamel industries. The great majority of stove plants in this country are large and becoming larger.

According to the Bureau of Foreign and Domestic Commerce, the value of the output of the chief branches of the enameling industries in 1925, the last year for which data are available was:

Plumbers ware[3]	$168,000,000
Stamped and enameled ware	154,000,000
Refrigerators	57,000,000
Stoves and ranges	296,000,000
Total	$675,000,000

Fully 80% of this total or ware having a value of $540,000,000 was made in plants having an output valued at $1,000,000 or more. For each $1,000,000 of output, units of this size can afford one ten-thousand-dollar-a-year man and two five- or six-thousand-dollar men. This means at least 500 first-class jobs and 1000 jobs of intermediate grade.

According to the *Mineral Resources of the United States* (*1927*), the value of clay products produced in the United States in 1925 was:

Brick and tile	$311,000,000
Pottery	112,000,000
Total	$423,000,000

Thus we find that the value of the output of the enameling industries is more than half again that of all the clay-products industries. The clay products were manufactured in 2417 plants, the number of large units being comparatively few. Therefore the ratio of first-class jobs in the enameling industries to those in the clay-products industries would be even higher than 16 to 10.

In 1925, the value of glass and glass products was $296,000,000. This was produced in 310 plants, most of the value being manufactured in large factories. There are probably as many first-class jobs available in the glass industries as in the clay-products industries, and about as many in the enamel industries as in glass and clay products together.

This does not mean that there are hundreds of ten-thousand-dollar jobs open for technical men. The positions of this class for purely technical men are almost nil. Nor does it mean that there are a thousand jobs that will pay five or six thousand dollars a year to technical men. It does mean that young men with a moderate amount of technical training

[3] Exclusive of ware made from clay, which are classed with clay products.

can obtain a fair start in these industries by virtue of such training and then, if they have an understanding of human nature, ambition, and vision, can progress along a variety of roads to positions of greater responsibility and higher pay. Provided their college training has developed these attributes, very few will continue indefinitely as technical men, and these will become directors of large research departments. In the college curricula outlined by the Committee last year, the technical and engineering subjects are bread and butter courses, but the business and cultural subjects are the big-money courses.

In regard to the suggestion that possibly men for the enameling industries should receive their training in schools other than ceramic schools, the Committee can say only that this is by far too often the case already. A majority of the better known technical men and practically all the plant and business executives in the enameling industries did receive their training in "schools other than ceramic schools." Unless the heads of the ceramic departments can be brought to alter materially their attitude toward education for the enameling industries this condition will continue and grow more pronounced.

The SOCIETY has claimed the technical work in the enameling industry as a branch of ceramics. It develops that the technical work in these industries are partly ceramic; partly, as to molding sand, molding operations, and refractories, on the border line between ceramics and metallurgy, and partly straight metallurgy. There is so great a need for this combination of technical work that it is sure to be given by some schools. The only question is whether it will be given by the departments of ceramics, thus holding the enormous enameling industries in the ceramic group, or whether it will be given over to the departments of metallurgy, which will mean that ultimately enameling of metals will become a division of the metallurgical industries. It seems that our ceramic schools have a certain moral obligation in this matter.

In the beginning of this report we spoke of the earnest desire of all ceramic educators to give their students the best education possible. Throughout this paper we have labored to show that the enameling industries are great business enterprises rather than a branch of science or engineering, and therefore the highest rewards both in money and respect of fellow men come to technically trained men who have in addition qualities known to be fostered by college training in the fundamentals of business and by the study of certain cultural subjects. Knowing the educators are really in earnest about making the best of their raw material, the lives of highly selected young men, the Committee feels confident it can obtain their coöperation in giving such courses.

HOMER F. STALEY, *Chairman*

ACTIVITIES OF THE SOCIETY

NEW MEMBERS RECEIVED FROM JUNE 1 TO JULY 1

CORPORATION

American Smelting and Refining Co., 120 Broadway, New York, N. Y., Walter F. Gross, Representative.

The Chase Foundry & Mfg. Co., Columbus, Ohio, A. J. Dunn, Representative.

PERSONAL

Blandford C. Burgess, Manager Tenn. Mineral Products Corp., Spruce Pine, N. C.

Albert Henry Carder, Sandon House, Kingswinford, nr. Dudley, Worcestershire, England, partner of C. Carder & Sons., Brierley Hill.

Roland Vivian Cullinan, P. O. Box 286, Johannesburg, Transvaal, S. Africa, Consolidated Rand Brick Pottery & Lime Co.

Louis J. Escoyez, 53 Rue de Ghislain-Tertre, Belgium (Refractories and Paving Tile).

Edwin B. Forse, Box 248, Perth Amboy, N. J., Works Manager, The Carborundum Co.

Carl H. Gross, 1137 Regent St., Schenectady, N. Y., Engineer of Vitreous Enamels, General Electric Co.

Theodore Kaufman, 18th and Rockwell Sts., Chicago, Ill., Manager, Refractories Division, S. Obermayer Co.

Virgil P. Owens, Middlesex Ave., Metuchen, N. J., Vice-President, Empire Floor and Wall Tile Mfg. Co., Inc., Matawan, N. J.

Wilfred B. Rowley, 70 Morris St., Williamstown, Victoria, Australia, Pottery Manager, Hoffman Brick, and Potteries, Ltd., Brunswick, Victoria.

Frank Russell, General Refractories, Ltd., Wicker Arches, Sheffield, England.

Leon Yeatman, Produits Céramiques et Refractaires, de Boulogne s/mer, 4 Rue Blanche Paris, France.

STUDENT

C. W. Gerster, Ohio State Univ., Columbus, Ohio.

H. Leslie Moody, Ohio State Univ., Columbus, Ohio.

Paul Laurens Smith, Bloomington High School, Box 403, Bloomington, Ill.

Membership Workers' Record

CORPORATION		STUDENT	
A. E. R. Westman	1	A. E. Baggs	1
Office	1	F. T. Heath	1
Total	2	Office	1
PERSONAL		Total	3
L. E. Barringer	1		
G. H. Brown	1		
Charles F. Geiger	1	Grand total	16
F. P. Knight, Jr.	1		
J. J. Moroney	1		
Dorothy A. Texter	1		
W. E. S. Turner	1		
Office	4		
Total	11		

ROSTER CHANGES IN JULY

Each month the *Bulletin* will publish the changes of address of the members listed in the Roster (see *Bull. Amer. Ceram. Soc.*, **8** [7], 187–254 (1929). By adding the names of the new members which are published each month and making the changes for those who have moved, the Roster may be kept up-to-date and useful.

Names Omitted from July Roster

The following names were inadvertently omitted from the Roster published in the July issue of the *Bulletin*.

Amberg, Charles R., Alfred University, Alfred, N. Y.
Ehman, Roy G., Pittsburgh Plate Glass Co., Crystal City, Mo.
Fallon, Frank J., The Stupa Koff Laboratories, 6617–27 Hamilton Ave., Pittsburgh, Pa.

Corporation Changes*

Bedford Mining Co., Inc., Leo L. Hunt (voter), Bedford, N. J. *Merged with* Consolidated Feldspar Corp., Attn., Leo L. Hunt, Trenton, N. J.

W. S., Dickey, Clay Mfg. Co., N. A. Dickey (voter), 116 New Montgomery St., Rialto Bldg., San Francisco, Calif. (604 Mission St., San Francisco, Calif.)

H. K. Ferguson, Co., H. S. Jacoby (voter), Hanna Bldg., Sta. B. to Main Office, Cleveland, Ohio. (4900 Euclid Ave.)

Gladding, McBean & Co., Paul S. MacMichael (voter), Auburn, Washington. (Seattle, Washington.)

Personal Changes*

Anderson, Y. R., c/o International Clay Products, Ltd., Prince Albert, Sask., Canada. (Young, Sask., Canada.)

Bonesteel, Mrs. Sara H., Victor, N. Y. (4427 N. Kenneth Ave., Chicago, Ill.)
Bopp, Harold F., 121—7th St., Dundee, Ill. (616 Park St., Elgin, Ill.)
Butler, Matthew W., c/o Frigidaire Corp., Chemical Laboratories, Plant No. 2, Dayton, Ohio. (229 West Hermon Ave., Dayton, Ohio.)
Byron, Oscar, 122 E. 42nd St., New York, N. Y. (22 W. 42nd St.)

Cook, Parker, Bromo-Seltzer Tower Bldg., Baltimore, Md. (Maryland Glass Corp.)

Darrah, W. A., 901 N. Oak Park Blvd., Oak Park, Ill. (Suite 1805, 208 W. Washington St., Chicago, Ill.)
Davis, Howard S., 4956 McPherson Ave., St. Louis, Mo. (4722—18th Ave., N. E. Seattle, Wash.)

Haberstroh, H. N., Johns-Manville Corp., 230 N. Michigan Ave., Chicago, Ill. (225 E. Superior, Chicago Ave., Sta. Chicago, Ill.)
Hall, Herman A., Hotel Haynes, York, Pa. (406 Elm St., Martins Ferry, Ohio.)
Hansard, W. C., 175 Lismore Ave., Glenside, Pa., Business address, Enfield Pottery & Tile Works, Enfield, Pa., Ceramic Engineer. (82 Huntington Rd., Atlanta, Ga.; formerly at Georgia School of Tech.)
Hendrich, Robert T., Titanium Alloy Mfg. Co., B. F. Keith Bldg., Euclid Ave. and E. 17th St., Cleveland, Ohio. (Titanium Alloy Mfg. Co., 6007 Euclid Ave., Cleveland, Ohio.)

Kier, Samuel M., Kier Fire Brick Co., Salina, Pa. (623 St. James St., Pittsburgh, Pa.)
Knowles, W. V., Titanium Alloy Mfg. Co., B. F. Keith Bldg., Euclid Ave. & E. 17th St., Cleveland, Ohio. (Titanium Alloy Mfg. Co., 6007 Euclid Ave., Cleveland, Ohio.)

Landrum, Robert D., Titanium Alloy Mfg. Co., B. F. Keith Bldg., Euclid Ave. and E. 17th St., Cleveland, Ohio. (Titanium Alloy Mfg. Co., 6007 Euclid Ave., Cleveland, Ohio.)

Marley, Henry E., 162 River St., Hornell, N. Y. (c/o Harshaw Chemical Co., Elyria, Ohio.)
Moncrieff, James W., 780 Woodlawn Ave., East Liverpool, Ohio. (418 Hilbert St., Kalamazoo, Mich.)

Scripture, Edward W., Jr., The Aluminum Co. of America, Research Bureau, New Kensington, Pa. (111 Washington Ave., Oakmont, Pa.)
Siegrist, Paul F., Mellon Institute, Pittsburgh, Pa. (Home: 267 W. Franklin St., White Hall, Ill. Business: White Hall Sewer Pipe & Stoneware Co.)

* Addresses within parentheses ( ) represent the old address.

Stevenson, Samuel, 3000 Washington, W., Station D, Cragin Station, Chicago, Ill. (1822 S. 58th Ave., Cicero, Ill.)
Svec, J. J., Carlyle-Labold Co., Portsmouth, Ohio. (Coral Ridge Clay Products Co., Coral Ridge, Ky.)

Vollrath, A. J., 500 Vollrath Blvd., Sheboygan, Wis. (2123 N. 6th St.)

Wangland, Harry E., General Steel Wares, Ltd., 5 Ardaven Place, London, Ontario, Canada. (Ardaven Place.)
Watson, Donald J., 173 Rector St., Perth Amboy, N. J. Federal Seaboard Terra Cotta Co., (101 Hyland Ave., Ames, Iowa; formerly a student at Iowa State College.
Watters, Curtis R., 411 Shuttle Meadow Ave., Kenmore, N. Y. (59 Washington Ave.)
Weinfurtner, E. M., North American Refractories Co., National City Bank Bldg., Cleveland, Ohio. (Ashland Fire Brick Co., Ashland, Ky.)

Student Changes*

Czolgos, Edmund P., 316 N. Kenilworth, Oak Park, Chicago, Ill. (4155 E. 71st St., Cleveland, Ohio.)

French, Gordon E., 173 Cameron St., Rochester, N. Y. (Alfred, N. Y.)

Musselman, John E., 234 Wentz St., Tiffin, Ohio. (176—15th Ave., Columbus, Ohio.)

Shardlow, L. Russel, N. Bloomfield, N. J. (Alfred, N. Y.)
Shaw, D. T. H., Massachusetts Institute of Technology Dormitories, Cambridge, Mass. (Ceramics Bldg. University of Illinois, Urbana, Ill.)

Witter, Raymond B., 146 Broad St., Matawan, N. J. (Alfred, N. Y.)
Wong, Edwin, 2127 Central Ave., Cleveland, Ohio. (724 W. Foster Ave., State College, Pa.)

Zwermann, Carl H., Jr., Robinson, Ill. (306 S. Cross St., Robinson, Ill.)

THE AMERICAN REFRACTORIES INSTITUTE ELECTION

At the Annual Meeting of the Institute, held on June 25 at Cleveland, Ohio, Officers and Directors were elected for the year 1929–30, as follows:

President, P. S. Kier, Kier Fire Brick Co., Pittsburgh, Pa.
1st Vice-President, W. B. Coullie, Harbison-Walker Refractories Co., Pittsburgh, Pa.
2nd Vice-President, Roger A. Hitchins, General Refractories Co., Philadelphia, Pa.
Treasurer, C. C. Edmunds, McLain Fire Brick Co., Pittsburgh, Pa.
Secretary, Dorothy A. Texter, 2218 Oliver Building, Pittsburgh, Pa.
Directors (3-year term 1929–1932):

U. S. Clark, The Howard Company, New Haven, Conn.
G. R. McClintock, Osceola Silica & Fire Brick Co., Pittsburgh, Pa.
P. S. Kier, Kier Fire Brick Co., Pittsburgh, Pa.
E. F. Myers, Ironton Fire Brick Co., Ironton, Ohio.
J. Claire Evans, Denver Fire Clay Co., Denver, Colo.
J. T. Roberts, Stockton Fire Brick Co., San Francisco, Calif.
J. L. Green, Laclede-Christy Clay Products Co., St. Louis, Mo.
C. H. King, Evens & Howard Fire Brick Co., St. Louis, Mo.

NOTES AND NEWS

REPORT OF PRELIMINARY MEETING ON MASONRY OPENING SIZES[1]

This conference was attended by the following representatives: Anderson, W. B., David Lupton's Sons Co., Philadelphia, Pa.; Bogert, E., Jr., Bogert & Carlough Co., 28 Peach St., Paterson, N. J.; Carlson, R. J., International Casement Co., Jamestown, N. Y.; Clark, J. B., The E. T. Barrowes Co., Portland, Maine; Clifford, E., G. S.

* Addresses within parentheses ( ) represent the old address.

[1] Division of Simplified Practice, U.S. Department of Commerce, Bureau of Standards, June 12, 1929.

Thorn Co., Philadelphia, Pa.; Darwin, W. P., Portland Cement Assn., Union Trust Bldg., Washington, D. C.; Ferry, A. A., Newman Manufacturing Co., Cincinnati, Ohio; Garratt, Frank, International Casement Co., Jamestown, N. Y.; Heath, Fred. T., Heath Cube Service (Inc.), 2525 N. High St., Columbus, Ohio; Jacobis, J., The Bogert & Carlough Co., Paterson, N. J.; Johnson, A. Z., Dahlstrom Metallic Door Co., Jamestown, N. Y. (also represents Hollow Metal Assn.); Jorss, K. F., Crittal Casement Window Co., Detroit, Mich.; Kern, L. E., American Institute of Architects & Central Committee on Lumber, 1741 New York Ave., N. W., Washington, D. C.; Kimbell, R. G., National Lumber Manufacturers Assn., Transportation Bldg., Washington, D. C.; King, A. S., David Lupton's Sons Company, Philadelphia, Pa.; Layng, J. M., Stewart Hartshorn Co., 250—5th Avenue, New York, N. Y.; Lockwood, J. B., Bureau of Foreign & Domestic Commerce, Department of Commerce; MacMahon, W. K., Division of Building & Housing, Bureau of Standards; McBurney, J. W., Common Brick Manufacturers Assn., 2121 Guarantee Title Bldg., Cleveland, Ohio; Morrow, W. V., *Metalcraft Magazine*, Jamestown, N. Y.; Palmer, L. A., American Face Brick Association, Bureau of Standards; Perkins, N. S., National Lumber Manufacturers Assn., Transportation Bldg., Washington, D. C.; Phelan, V. B., Division of Building & Housing, Bureau of Standards; Reading, W. D., Rolscreen Company, 1322 Land Title Bldg., Philadelphia, Pa.; Reed, A. G., Crittall Casement Window Co., Detroit, Michigan; Reevas, H. K., The Higgins Manufacturing Company, Newport, Kentucky; Reynolds, F. B., Columbia Mills (Inc.), 225—5th Avenue, New York, N. Y.; Rittenour, F. H., National Radiator Corp., 2205—5th St., N. E., Washington, D. C.; Robinson, L. B., Rolscreen Company, Pella, Iowa; Russell, W. E., National Tent & Awning Mfg. Assn., Chicago, Ill.; Schurecht, H. G., National Terra Cotta Society, Bureau of Standards; Schoenberger, A. H., Cincinnati Fly Screen Company, Cincinnati, Ohio.

Those from the Department of Commerce, Division of Simplified Practice were: E. W. Ely, H. R. Colwell, W. E. Braithwaite, and P. H. H. Dunn.

The meeting was opened by P. H. H. Dunn, who outlined briefly the services of the Division of Simplified Practice in coöperating with industry for the elimination of avoidable waste. The history of the movement for a standard list of masonry opening sizes based on a constant variation was then traced to the present meeting.

LeRoy E. Kern, Technical Secretary of the Structural Service Department of the American Institute of Architects, traced the history of windows from their inception down to the modern type used today. Mr. Kern emphasized the fact that any work looking toward the simplification of masonry opening sizes should be confined to that type of structure which is not monumental. From the architectural point of view it would be far more satisfactory to go about the masonry opening size proposition from a standpoint of the masonry which goes around the window. In other words, any set of standards which are arrived at should bear in mind very definite sizes of brick, tile, and concrete blocks.

F. T. Heath presented a paper which was based on a study that he has been making for some years past of this very problem. Mr. Heath pointed out the fact that while there are standards for brick sizes, standard tile sizes, standard window sizes, and standard concrete block sizes none of these standards have been coördinated or have any regard for the standards in related material. He pointed out that such standards which have no regard for allied products frequently cause more confusion than lack of standards. He stated that he believed any proposed program along the lines of standard masonry opening sizes should coördinate and bring into uniformity existing standards for masonry products and it should be based on a careful study of the existing standards of the various industries.

In the discussion which followed it was pointed out by steel window manufacturers that the problem as presented by standards for brick sizes might be overcome without much difficulty. W. B. Anderson suggested that it was reasonable to believe that standards could be drafted in even inches and that such standards would not only be satisfactory to the architects but would be a distinct advantage to them.

Frank Garratt, in outlining the problems which faced the manufacturers of windows in England after the World War, showed how they had arrived at standard sizes which had proved satisfactory to all concerned and had at the same time been recognized by all producers of masonry products.

Considerable discussion was held as to the importance of brick and tile sizes and upon motion of LeRoy Kern, seconded by W. B. Anderson, the chair was authorized to appoint a committee to be composed of one manufacturer of blocks, one manufacturer of brick, one manufacturer of tile, one manufacturer of steel windows, one manufacturer of steel frames, one manufacturer of wood windows and frames, and one architect. This committee would be instructed to make a detailed study of the entire proposition in all its ramifications and to draft a recommendation based on its studies, which recommendation would be submitted to a general conference of all interests for approval or modification.

MEETING OF COMMITTEE C-3 ON BRICK

The meeting of Committee C-3 on Brick, A.S.T.M. was held in Atlantic City, June 25, 1929. Those attending this meeting were: Messrs. Boyd, Burbidge, Chapman, Ingberg, Kern, Vogdes (for Krauss), Lawson, Lent, Lenth, M. B. Reilly (for Long), Lysle, McBurney, Murray, Palmer, Pugh, Welchley (for Schlake), Schlessinger, Shelley, Kelch, and Walton.

Members represented by unused proxies: Greaves-Walker, Koch, Petts, Purdy, Stringer.

The following results on letter ballots on standards were read:

	Affirmative	Negative	Not Voting
Proposed Revision of Tentative Standard for Paving Brick (C7–28T)	32	1	5
Advancement of Tentative Standard Building Brick (made from clay or shale) (C62–28T)	34	1	3
Withdrawal of Standard Specification for Paving Brick (C7–15)	34	0	4

The Annual Report for 1929 received 38 affirmative ballots and 0 negative ballots.

Reports of the Sub-Committees were given.

Kern discussed questions raised as to the present standard size of brick and told of Simplified Practice Meeting recently held at Washington. Moved by Boyd that the Chair appoint a sub-committee on study of brick sizes. Favorably discussed by Kelch, Kern, Lent, and Ingberg. The Chair appointed, Kern, Chairman, and Pugh, Lent, Kelch, Koch, Walton, and Davis to serve.

STATE GEOLOGISTS[1]

Alabama: Geological Survey of Alabama; *Walter B. Jones*, State Geologist, University.
Arizona: Arizona Bureau of Mines; *G. M. Butler*, Dean and Director, Tucson.
Arkansas: Geological Survey of Arkansas; *Dr. George C. Branner*, State Geologist, Little Rock.
California: California State Mining Bureau; *Walter W. Bradley*, State Mineralogist, San Francisco.
Colorado: Colorado State Geological Survey; *Dr. R. D. George*, State Geologist, Boulder.
Connecticut: State Geological and Natural History Survey; *Dr. W. E. Britton*, Supt., Box 1106, New Haven.
Florida: Florida State Geological Survey; *Herman Gunter*, State Geologist, Tallahassee.

[1] Correct as of Feb. 13, 1929.

Georgia: Geological Survey of Georgia; *Dr. S. W. McCallie*, State Geologist, Atlanta.
Idaho: Idaho Bureau of Mines and Geology, Moscow.
Illinois: State Geological Survey Division; *Dr. M. M. Leighton*, Chief, Urbana.
Indiana: Division of Geology, Dept. of Conservation; *Dr. W. N. Logan*, State Geologist, Indianapolis.
Iowa: Iowa Geological Survey; *Dr. G. F. Kay*, State Geologist, Iowa City.
Kansas: State Geological Survey; *Dr. Raymond C. Moore*, State Geologist, Dr. Kenneth K. Landes, Act. State Geologist, Lawrence.
Kentucky: Kentucky Geological Survey; *Dr. W. R. Jillson*, State Geologist, Frankfort.
Maryland: State Geological Survey, *Dr. E. B. Mathews*, State Geologist, Baltimore.
Michigan: Michigan Geological and Biological Survey; *R. A. Smith*, Director, Lansing.
Minnesota: State Geologist, *Dr. W. H. Emmons*, Minneapolis.
Mississippi: Geologic, Economic, and Topographic Survey of Mississippi; *E. N. Lowe*, Director, University.
Missouri: Bureau of Geology and Mines, *H. A. Buehler*, State Geologist, Rolla.
Montana: *Dr. Francis Thomson*, President, University of Montana, Missoula.
Nebraska: Nebraska State Museum; *Prof. G. E. Condra*, Director, Nebraska Conservation Division, University.
New Jersey: Geological Survey of New Jersey; *Dr. H. B. Kümmel*, State Geologist, Trenton.
New Mexico: *E. H. Wells*, New Mexico School of Mines, Socorro.
New York: Science Division (Geological Survey) of the Education Dept., Chas. Adams, Director; *D. H. Newland*, State Geologist, State Museum, Albany.
Nevada: *J. Claude Jones*, School of Mines, Reno.
North Carolina: N. Carolina Dept. of Conservation and Development, *H. J. Bryson*, Acting State Geologist, Raleigh.
North Dakota: N. Dakota Geological Survey, *Prof. A. G. Leonard*, State Geologist, Grand Forks.
Ohio: Geological Survey of Ohio; *Wilbur Stout*, State Geologist, Columbus.
Oklahoma: Oklahoma Geological Survey; *Charles N. Gould*, Director, Norman.
Pennsylvania: Topographical and Geological Survey Commission, *Dr. George H. Ashley*, State Geologist, Harrisburg.
Rhode Island: Natural Resources Survey of Rhode Island; *Charles W. Brown*, Supt., Providence.
South Carolina: *Professor Stephen Taber*, State Geological Survey, State Geologist, Columbia.
South Dakota: Geological Survey of S. Dakota; *E. P. Rothrock*, State Geologist, Vermilion.
Tennessee: Tennessee State Geological Survey; *Walter F. Pond*, State Geologist, Nashville.
Texas: Bureau of Economic Geology, *E. H. Sellards*, Associate Director, Austin.
Utah: Agricultural College of Utah; *Wm. Peterson*, Director and State Geologist, Logan.
Virginia: State Geological Survey of Virginia; *Arthur Bevan*, University (or Charlottesville).
Vermont: Geological Survey of Vermont; *Dr. George H. Perkins*, State Geologist, Burlington.
Washington: State Geological Survey of Washington; *Dr. Harold E. Culver*, State Geologist, Pullman.
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Wyoming: Geological Survey of Wyoming; *John G. Marzel*, State Geologist, Cheyenne.

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Richard Wainford, Trenton Flint & Spar Co., Trenton, N. J.
Norman G. Smith, Maine Feldspar Co., Brunswick, Me.
H. G. MacLear, Green Hill Mining Co., 141 Broadway, New York, N. Y.
Commissioner: W. J. Parker, 7 East 44th St., New York, N. Y.

Mr. Parker as Commissioner of the Institute will work toward carrying out the purpose of the Institute with the idea of improving the industry as a unit.

SUMMER MEETING, OHIO CERAMIC INDUSTRIES ASSN.

June 28, 29, 1929

The semi-annual meeting of the Ohio Ceramic Industries Association was held in Zanesville and Roseville, June 28 and 29. Approximately one hundred were in attendance.

Luncheon and dinner were served in the dining room of the Zanesville Golf Club, Friday, and the afternoon and evening sessions were held in the large assembly room of the Club.

The first speaker of the afternoon was Professor H. H. Maynard, of the College of Commerce, Ohio State University. Professor Maynard gave a talk on "Present Trends in the Field of Marketing." He stressed the point that cost accounting should be extended to the sales department. Some effort should be made to find out what it costs to sell a man in reference to the amount of money and time expended by the salesman. If certain men or certain territories required as much money to sell them as the profit gained by their business, they should be dropped. He urged that each manufacturer look into the question carefully as to whether it was cheaper to send salesmen by train or automobile. He suggested that a close scrutiny of the costs of manufacture and the cost of selling the manufactured product would repay a company many times. Professor Maynard's central idea was an urge to find the facts in regard to sales costs.

Professor Maynard was followed on the program by Professor C. H. Chase, also of the College of Commerce, Extension Department, Ohio State University. Professor Chase stated that the American market was not satiated but merely undiscovered. He presented a number of interesting figures to prove his point. He pointed out that business deals are really in cycles, and that the first step only has been completed in the cycle when goods are offered for sale. We must help the customer to buy after we have established a desire to buy. He urged that instead of running down a competitor's product, an attempt at coöperation be made. The chief object is to make the market *ceramic conscious*. Then, only, shall we be able to compete on equal terms with competing products. The more goods bought and sold, the wider the general market. The more people engaged in the manufacture or sale of different materials, the wider the market for all materials. He suggested that a greater amount of coöperation would be beneficial and suggested an organization made up of *all trade associations* to further this project. The object of this project would be to create and stabilize buying power.

The remarks of Professors Chase and Maynard bought forth considerable discussion. President McAfee called on B. T. Williams of the Vitrefrax Corporation, J. L. Murphy of the Nelsonville Brick Company, and R. C. Purdy of the AMERICAN CERAMIC SOCIETY for their views. Some very interesting contributions were made. The desirability of a salesman knowing more about his product, its service, uses, and ad-

vantages was stressed. Sales service is becoming a necessity to any successful sales endeavor.

Upon the conclusion of this discussion, President McAfee called for reports from the various committees. Mr. Christman, in the absence of Mr. Bales, presented a report for the Refractories Research Committee. He reported that the work outlined by the Committee had progressed very well and further plans were being made.

J. L. Murphy, reporting for the Public Relations Committee, stated that considerable work had been accomplished. The Committee had been instrumental in passing a bill authorizing a coöperation between the University and the Public Welfare Department which had as its aim the Roseville Experimental Plant and the proposed whiteware station. He explained the reason for the committee's action in regard to the Gas Tax bill. He stated that, after consideration, it was deemed best to back this bill inasmuch as the industries would be taxed for the money if it was not passed. Legislation of interest to the sewer pipe men was also taken care of. The chief item occupying the Committee's attention at the present time is an endeavor to persuade the Welfare Department that it would be unfair to the overcrowded drain tile industry of the state for them to erect and operate a drain tile plant to be run by prison labor. This was generally discussed by the Association.

President McAfee appointed a Resolutions Committee to put certain recommendation presented to the Association in definite form. The following resolutions were presented and approved:

Be it resolved that: (1) The Officers and Committee on Education take such steps to foster courses at Ohio State University on the use of building materials in masonry construction with a proportionate share of time being spent on the use of clay products.
(2) That instruction on paving brick and brick paving be included in the short courses on highway engineering.
(3) That this Association, through the Public Relations Committee, oppose the erection and operation of a drain tile plant by the State Welfare Department.
(4) That this Association approve the action of the AMERICAN CERAMIC SOCIETY in calling a conference of state ceramic association executives.

Professor John Younger presented a paper on "Plant Management with Special Emphasis on Foreman Training." Professor Younger gave some very interesting information in regard to the system of piece work. He urged that the manufacturers pay more attention to the routing of orders as they go through the plant and to the filling of them in the shortest possible time.

President McAfee presented some very pertinent information which he had discovered in his own plant. Interesting contributions were made by Professor Nold of the O. S. U. Mining Department, D. V. Robison of the Mosaic Tile Company and several other members.

Saturday morning the members divided into two groups: The White Wares group visited the plant of the Mosaic Tile Company and the Heavy Clay group visited the Experimental Plant at Roseville.

At the Experimental Plant, Mr. Bole described the research being carried on at the Station and the various projects under investigation. Two methods for making a light weight building unit were demonstrated to the members of the Heavy Clay Division.

Meetings of the Refractories Research Committee and the Drain Tile Division were held at Roseville in separate groups.

After an inspection of the plant, luncheon was served in the prison dormitory in regular prison fashion.

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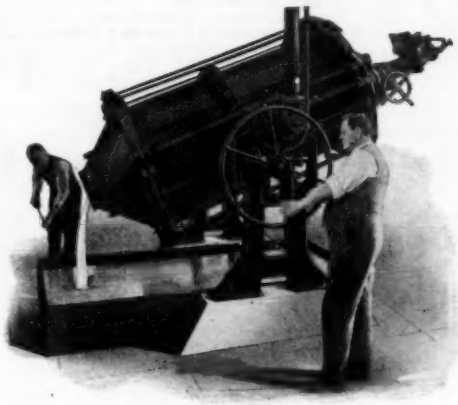

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F

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G

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Golding Sons Company
Harshaw Chemical Co.

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Vitro Mfg. Co.

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Golding Sons Co.
Harshaw Chemical Co.
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I

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J

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K

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Harshaw Chemical Co.
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M

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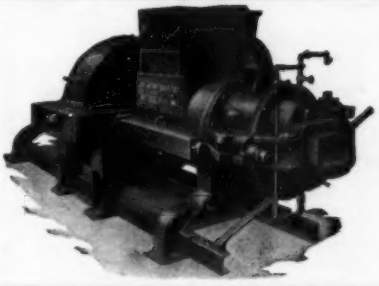

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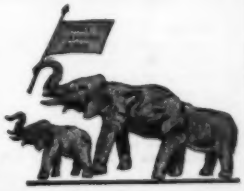

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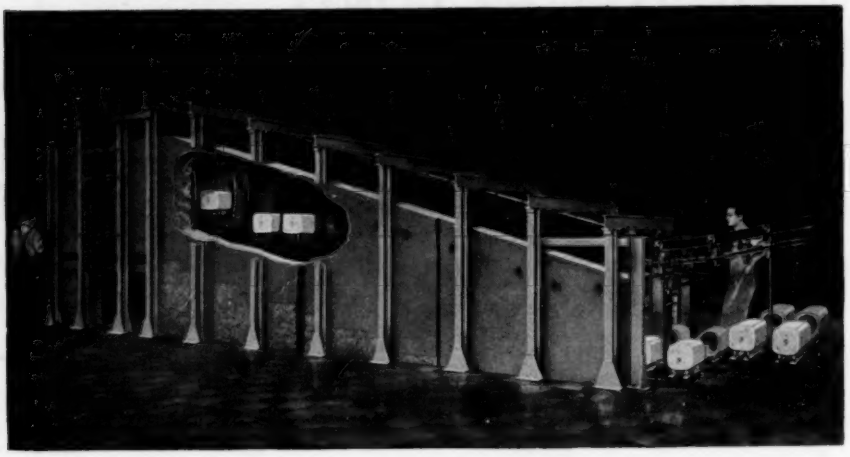

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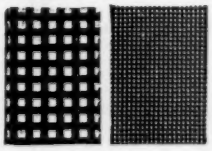

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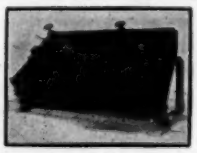

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